AS-BUILT BASELINE MONITORING REPORT

Final

SHAKE RAG MITIGATION SITE

Madison County, NC
DEQ Contract No. 7190
DMS Project No. 100018
USACE Action ID No. SAW-2017-01570
DWR Certification No. 17-1157

French Broad River Basin
HUC 06010105

Data Collection Period: December 2019 – March 2020
Draft Submission Date: April 7, 2020
Final Submission Date: April 24, 2020

PREPARED FOR:

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April 24, 2020

Mr. Matthew Reid
Western Project Manager
Division of Mitigation Services
5 Ravenscroft Dr., Suite 102
Asheville, NC 28801

RE: **Response to Draft As-Built Monitoring Report Review**
Shake Rag Mitigation Site, Madison County
French Broad River Basin: 06010105
DMS Project ID No. 100018
DEQ Contract #7190

Dear Mr. Reid:

Wildlands Engineering, Inc. (Wildlands) has reviewed the Division of Mitigation Services (DMS) comments from the Draft As-built Monitoring report for the Shake Rag Mitigation Site provided in bold type below and offers the following responses in italics.

General:

The NC IRT has indicated that project credits are determined at the IRT Mitigation Plan approval stage unless major changes or deviations occur. The Shake Rag Mitigation Site was approved for 6,655.6 SMUs (cold). Please update the report and text accordingly.

Based on DMS's comment, we revisited the Reach 2/3 station break location and proposed versus implemented activities. The implemented activities were consistent with the proposed activities and therefore we revised the reach break to be consistent with Mitigation Plan stationing and mitigation approach table.

Table 1:

The Project Components section of the table should be identical to the DMS template. Please do not make any changes or add additional columns to the table. Remove the "Project Credit" column and replace with a "Comments" column. Reformat to match attached table.

Table 1 has been reformatted to match the DMS template.

Table 1: The Project Credits section of the table should list the agreed upon credits from the Mitigation Plan. Please update.

The project credits section of Table 1 has been updated to match the approved amount of credits from the Mitigation Plan.

Table 2:

Please add "Institution Date - May-17" to first row of table. Remove "Temporary and Permanent Seed lines. Remove dates from Activities not yet completed (Year1 – Year7).

Table 2 has been updated.

Profile Plots:

Data is not legible at the current scale. Please increase y-axis scale or adjust as necessary.

Profile plot scales on all reaches have been adjusted so that the survey data is legible.

Electronic Support Files:

- **Please include Asbuilt .dwg file in final electronic support files.**
- **Please include the WEI design .dwg file in the final electronic support files.**

The Asbuilt .dwg and WEI design .dwg have been included in the final electronic support files.

Enclosed please find two (2) hard copies of the Final As-built Monitoring Report; an electronic copy of files has been provided by email. Please contact me at 828-545-3865 if you have any questions.

Sincerely,

Jake McLean
Project Manager
jmclean@wildlandseng.com

EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (Wildlands) implemented a full-delivery stream mitigation project at the Shake Rag Mitigation Site (Site) for the North Carolina Department of Environmental Quality (DEQ) Division of Mitigation Services (DMS). The project restored, enhanced, and preserved a total of 9,273 linear feet (LF) of perennial and intermittent stream in Madison County, NC. The Site is located within the DMS targeted watershed for the French Broad River Basin Hydrologic Unit Code (HUC) 06010105110020 and the NC Division of Water Resources (NCDWR) Subbasin 04-03-04. The project is providing 6,655.600 stream mitigation units (SMUs) for the French Broad River Basin HUC 06010105 (French Broad 05).

The watershed has a long history of agricultural activity and most of the stressors to stream functions are related to historic and current land use practices. Prior to construction, the major stream stressors for the Site were livestock trampling and fecal coliform inputs, stream bed incision and bank scour, a lack of stabilizing stream bank and riparian vegetation, and ditching and/or piping from agricultural activities. The effects of these stressors resulted in degraded water quality and habitat throughout the Site's watershed when compared to reference conditions. The project approach for the Site focused on evaluating the Site's existing functional condition and its potential for recovery and need for intervention.

The project goals defined in the mitigation plan (Wildlands, 2019) were established with careful consideration of 2009 French Broad River Basin Restoration Priorities (RBRP) goals and objectives to address stressors identified in the watershed. The established project goals include:

- Improve stream channel stability,
- Exclude livestock from stream channels,
- Reconstruct channels and flood-prone areas with appropriate geomorphology,
- Improve in-stream habitat,
- Reduce sediment and nutrient input from adjacent cattle pastures and unpaved roads,
- Restore and enhance native riparian and upland vegetation, and
- Permanently protect the Site from harmful uses.

The Site construction and as-built surveys were completed between December 2019 and February 2020. Planting and baseline vegetation data collection occurred between December 2019 and January 2020. Minimal adjustments were made during construction and specific changes are detailed in Section 5.1. Baseline (MY0) profiles and cross-section dimensions closely match the design parameters. The Site has been built as designed and is expected to meet the upcoming monitoring year's success criteria.

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Section 1: PROJECT GOALS, BACKGROUND, AND ATTRIBUTES

1.1 Project Location and Setting

The Shake Rag Mitigation Site (Site) is located in Madison County approximately 19 miles north of Asheville and 4 miles northeast of the town of Mars Hill in the French Broad River Basin HUC 06010105110020 and NCDWR Subbasin 04-03-04 (Figure 1). Located in the Blue Ridge belt within the Blue Ridge physiographic province (NCGS, 1985), the project watershed is dominated by agricultural and steep forested land.

In general, the Site encompasses three primary drainage areas that are comprised of smaller valleys. The three primary drainage areas are Shake Rag Branch, UT1, and UT6. All project stream reaches within these drainages originate from steep, forested headwater valleys before transitioning to open pastureland situated in wider valley bottoms further downstream. Shake Rag Branch's valley begins as a steep, colluvial, V-shaped valley, which gradually widens into a moderately confined alluvial bottom as it moves downstream. UT1A, UT3, UT4, and UT8 have steep valleys with much broader valley bottoms, while UT1, UT2, UT5, UT6, and UT7 flow through steep, colluvial, V-shaped valleys for their entire length in the project area. Shake Rag Branch drains 163 acres, UT1 drains 70 acres, and UT6 drains 43 acres of rural land.

Prior to construction activities, the Site was in hay production in the valley bottom, with cattle grazing along valley side slopes and access to the steeper forested areas. Riparian buffers were absent except in the steepest upper portions of the site. The streams throughout the Site were in various stages of impairment related to the current and historical agricultural uses. Many of the streams were buried in rock-lined channels or pipes approximately 50 years ago.

Pre-construction conditions are outlined in Table 4 of Appendix 1 and Table 6 of Appendix 2.

1.2 Project Goals and Objectives

The Site is providing numerous ecological benefits within the French Broad River Basin. The project goals were established with careful consideration to address stressors that were identified in the RBRP (EEP, 2009). Improvements to water quality and ecological processes are outlined below as project goals and objectives.

Goals	Objectives
Improve the stability of stream channels.	Reconstruct stream channels slated for restoration with stable dimensions and appropriate depth relative to the existing flood-prone area. Add bank revetments and in-stream structures to protect restored/enhanced streams.
Exclude livestock from stream channels.	Install livestock fencing and watering systems as needed to exclude livestock from stream channels and riparian areas.
Reconstruct channels and flood prone areas with appropriate geomorphology.	Daylight buried or piped streams, remove man-made impoundments, and restore historic valley profiles. Reconstruct stream channels with bankfull dimensions and construct flood-prone areas consistent with reference reach findings.
Improve instream habitat.	Install habitat features such as cascading riffle-pool sequences, lunker logs, and brush toes on restored reaches. Add woody materials to channel beds. Construct pools of varying depth. Remove online farm pond.
Reduce sediment and nutrient input from adjacent cattle grazing areas and unpaved roads.	Construct one step-pool conveyance BMP to treat contributing 17-acre drainage area that is subject to nutrient and fecal coliform loading from cattle. Relocate unpaved roads outside of riparian corridor. Grade and plant forested buffer with native vegetation.
Restore and enhance native riparian and upland vegetation.	Convert active hay fields and cattle pasture to forested riparian buffers along all Site streams, which will slow and treat runoff from adjacent agriculture before entering streams. Protect and enhance existing forested riparian buffers. Treat invasive species.
Permanently protect the Site from harmful uses.	Establish a conservation easement on the Site. Exclude livestock from Site streams.

1.3 Project Structure, Restoration Type and Approach

The final mitigation plan was submitted and accepted by DMS in January of 2019 and the IRT in March of 2019. Construction activities were completed in January 2020 by Baker Grading & Landscaping, Inc. Kee Mapping & Surveying, PLLC. completed the as-built survey in February 2020. Planting was completed following construction in the January 2020 by Bruton Natural Systems, Inc. Field adjustments made during construction are described in further detail in section 5.1 and depicted in the Record Drawings in Appendix 4. Please refer to Appendix 1 for detailed project activity, history, contact information, and watershed/site background information.

1.3.1 Project Structure

Project mitigation components are outlined in the Project Components and Mitigation Credits Table (Table 1) and depicted in the Monitoring Plan View Maps (Figures 3.0-3.4) that are located in Appendix 1.

1.3.2 Restoration Type and Approach

The design approach for this Site was chosen based on the surrounding landscape, climate, natural vegetation communities but also with thorough consideration to existing watershed conditions and trajectory. The project includes stream restoration, enhancement, and preservation. The specific proposed stream approaches are illustrated in Figure 2 and detailed below. The Site vegetative planting plan is depicted on sheet 2.1 through 2.4 of the record drawings located in Appendix 4.

Shake Rag Branch Drainage

Shake Rag Branch and UT7

Shake Rag Branch Reach 1 and UT7 both originate from steep, confined, wooded valleys and exhibit stable step-pool morphology. These headwater streams are preserved until their confluence, which marks the beginning of Shake Rag Branch Reach 2. Reach 2 begins at station 907+00 where the valley slope decreases from 30% to 23%. About midway along this reach, the channel enters wider and flatter valley with a slope of 15%. An enhancement II approach was implemented throughout the reach by removing invasive vegetation, planting native buffer species, removing woody debris covering the channel, and excluding cattle from the project area. After the woody debris was removed from Reach 2, the channel thalweg was re-established and the banks were reshaped with grade control installed, as necessary, along the channel profile.

Shake Rag Branch Reach 3 begins at station 909+21 where the valley slope gradually decreases from 13% to 10%. The majority of Reach 3 had previously been buried, so a priority 1 restoration approach was utilized to re-establish stable channel dimensions, pattern, and profile. The design alignment generally follows the low point in the valley as a Rosgen A4a+/B4a-type stream.

Shake Rag Branch Reach 4 begins at station 923+18. It originates at the outlet of the most downstream culvert of Reach 3 and terminates just upstream of the (buried) UT8 confluence. Downstream of the culvert outlet, the channel continues as a Rosgen A4/B4a-type stream and flows alongside a steep hillslope on the right edge of the valley for most of the reach. An enhancement I approach was applied throughout Reach 4 and consisted of removing invasive vegetation, planting native buffer vegetation, decommissioning an adjacent farm road along the left terrace, and re-establishing stable channel dimensions and profiles within selected reach segments.

Shake Rag Branch Reach 5 begins at its confluence with UT8 at station 927+03 and extends to the lower project limits of the Site. A priority 1 approach was implemented along the majority of the reach. A short section of priority 2 restoration was implemented at the downstream extent of the reach to tie-in the new channel alignment with the existing channel. A farm road that had previously bordered the left bank of Reach 5 was relocated to the east, outside of the easement. Reach 5 was restored to a Rosgen A4/B4a-type stream to re-establish stable dimension, pattern, and profile.

UT3

UT3 Reach 1 originates as a perennial stream in a steep, confined, valley with an overall valley slope of 18%. Reach 1 exhibited stable banks and step-pool morphology thus an enhancement II approach was utilized with native buffer plantings and cattle exclusion. UT3 Reach 2 begins at station 304+26. A priority 1 restoration approach was implemented by establishing a new Rosgen A4/B4a-type stream channel through the low point of the original valley and abandoning the ditched diversion channel. The downstream portion of UT3 Reach 2 that had previous flowed underground was daylighted and restored to an appropriately sized channel. UT3 Reach 2 flows into Shake Rag Branch Reach 3 from the right floodplain at station 314+70.

UT8

UT8 had been previously buried in a pipe with flow originating from an upstream pond and was restored using a priority 1 approach as a Rosgen A4/B4a-type stream until it enters Shake Rag Branch Reach 5 from the left floodplain at station 802+06. UT8's valley has a broad bottom with an overall slope of 9%.

UT4

A step pool stormwater conveyance (SPSC) BMP was constructed in the upper drainage area of UT4 to treat concentrated agricultural runoff. UT4 begins at the downstream extend of the SPSC BMP where the restoration approach included establishing an open Rosgen A4/B4a-type stream channel that follows the low point of the valley using a priority 1 approach. The valley has a broad bottom with an overall slope of 13%. UT4 joins Shake Rag Branch Reach 5 at station 409+56 from the right floodplain.

UT1 Drainage

UT1 and UT1A

UT1 Reach 1 enters the project boundary as a perennial stream and is classified as a Rosgen A4a+-type stream. An enhancement II approach was applied by enhancing the buffer vegetation, excluding cattle, and decommissioning an adjacent farm road along the left terrace. A portion of UT1, approximately 130 LF, was excluded from the easement area where an existing log cabin, footbridge, and cookhouse are located. A similar approach of enhancement II was applied to UT1A, which also excluded the downstream channel limits from station 151+18 to its confluence with UT1, due to its close proximity to the log cabin. UT1 Reach 2 begins at station 110+90. An enhancement I approach was implemented on this reach. Stream work included draining the upstream pond and excavating a steeper valley through the pond bed to support a step-pool channel morphology. A priority 1 approach was used to create the Rosgen A4a+/B4a-type step-pool channel. Overall, the valley slopes of these reaches range from 33% at the headwaters to 11% along the valley bottom.

UT2

UT2 Reach 1 also enters the Site as a perennial stream and is classified as a Rosgen A4a+/B4a stream with stable pre-construction dimensions. An enhancement level II approach was employed by enhancing the buffer with native vegetation and excluding cattle from the easement area. UT2 Reach 2 begins at station 202+50. Priority 1 restoration was used to re-align the channel to the center of the valley. Since the valley slope is over 15%, it was designed as a Rosgen A4a+/B4a stream with a series of step-pools to dissipate energy. UT2 Reach 2 joins UT1 Reach 2 at station 205+80 from the right floodplain.

UT6 Drainage

UT5 and UT6

UT5 originates downstream of a small linear wetland that is located upstream of the conservation easement boundary. At the lower portion of the easement limits, UT5 joins UT6 at station 504+83 from the left floodplain. UT6 originates as a jurisdictional channel at the outlet of a pipe below an existing culvert crossing located just upstream of the conservation easement boundary. The channel then flows through a small linear wetland before becoming perennial at station 601+87, which marks the creditable start of the project reach limits for UT6. An enhancement II approach was applied on both UT5 and UT6 and included enhancing buffer areas with native vegetation and excluding cattle from easement area. Additional enhancement activities were implemented on UT6 and included the removal of streamside spoil piles from the right top of bank and the relocation of an unpaved road from the easement. Both UT5 and UT6 flow through steep, V-shaped valleys with overall slopes ranging from 10 to 12 percent. They are classified as Rosgen B4a-type streams with stable pre-construction banks and morphology.

Vegetation and Planting Plan

The riparian buffer was planted with native bare root saplings, while stream banks were planted with live stakes and the channel toe was planted with multiple herbaceous species. Permanent herbaceous seed was spread on streambanks, floodplain terrace areas, and disturbed areas within the project easement. Invasive species within the riparian buffer were treated before the onset of construction and will continue to be monitored and managed throughout the monitoring period.

1.4 Project History, Contacts and Attribute Data

The Site was restored by Wildlands through a Full Delivery contract with DMS. Tables 2, 3, and 4 in Appendix 1 provide detailed information regarding the project activity and reporting history, project contacts, and project baseline information and attributes.

Section 2: PERFORMANCE STANDARDS

The stream and wetland performance criteria for the Site follow approved performance criteria presented in the Shake Rag Mitigation Site Mitigation Plan (2019) and is based on performance criteria presented in the DMS Mitigation Plan Template (June 2017), the Annual Monitoring and Closeout Reporting Template (June 2017), and the Stream and Wetland Mitigation Guidance issued in October 2016 by the USACE. Annual monitoring and semi-annual site visits will be conducted to assess the condition of the finished project. Specific performance standard components are proposed for stream morphology, hydrology, and vegetation. Performance criteria will be evaluated throughout the seven-year post-construction monitoring period. The monitoring program designed to verify that performance standards are met is described in Section 3.

2.1 Stream Morphological Parameters and Channel Stability

2.1.1 Dimension

Riffle cross-sections on the restoration reaches should be stable and should show little change in bankfull area, maximum depth ratio, and width-to-depth ratio. All riffle cross-sections should fall within the parameters defined for the designated stream type. If any changes do occur, these changes will be evaluated to assess whether the stream channel is showing signs of instability. Indicators of instability include a vertically incising thalweg or eroding channel banks. Remedial action would not be taken if channel changes indicate a movement toward stability. Please note that Shake Rag Branch Reach 5 and UT8, due to existing landforms, are expected to have a wider flood-prone width and an entrenchment ratio greater than 2.2.

2.1.2 Pattern and Profile

A longitudinal profile was conducted as part of the as-built survey to provide a baseline for comparison should it become necessary to perform longitudinal profile surveys later during monitoring for future comparison. Annual longitudinal profile surveys are not required during the seven-year monitoring period unless other indicators during the annual monitoring indicate a trend toward vertical and lateral instability. If a longitudinal profile is deemed necessary, monitoring will follow standards as described in the 2016 USACE Stream and Wetland Mitigation Guidance for the necessary reaches.

Restoration reaches must remain vertically stable throughout the monitoring period with little indication of downcutting or significant aggradation. Deposition of sediments at certain locations (such as the inside of meander bends) is expected and acceptable. Changes in pool depth are not an indication of vertical instability. Restoration reaches must remain laterally stable and major changes planform pattern dimensions and sinuosity should not occur. However, migration of meanders on alluvial channels is not an indication of instability if cross sectional dimensions continue to meet the requirements.

2.1.3 Substrate

A pebble count was conducted at each surveyed riffle to characterize the pavement during the baseline monitoring only. A reach-wide pebble count will be performed in each restoration reach for monitoring years 1, 2, 3, 5 and 7. Reach-wide counts will be conducted for classification purposes. Substrate materials in the restoration reaches should indicate a progression towards or the maintenance of coarser materials in the riffle features and smaller particles in the pool features. However, natural variations in pool and riffle substrate is expected as a result of sediment transport processes in steeper sloped channels.

2.1.4 Photo Documentation

Photographs should illustrate the Site's vegetation and morphological stability on an annual basis. Cross-section photos should demonstrate no excessive erosion or degradation of the banks. Longitudinal photos should indicate the absence of persistent of mid-channel bars or vertical incision. Grade control structures should remain stable. Deposition of sediment on the bank side of vane arms is preferable. Maintenance of scour pools on the channel side of vane arms is expected.

2.2 Hydrology

Stream hydrologic monitoring will be conducted on stream mitigation reaches that utilize restoration and/or enhancement level I approaches where in-stream work conducted alters channel dimensions below the bankfull elevation.

2.2.1 Bankfull Events

The occurrence of bankfull events will be documented throughout the monitoring period. Four bankfull flow events must be documented within the seven-year monitoring period. The four bankfull events must occur in separate years.

2.2.2 Baseflow Monitoring

The occurrence of baseflow will be documented on intermittent streams to track the frequency and duration of stream flow events. Continuous surface water flow within the tributaries must occur every year for at least 30 consecutive days during the prescribed monitoring period. This 30-day period can occur at any point during the year. Additional monitoring may be required if surface water flow cannot be documented due to abnormally dry conditions.

2.3 Vegetation

The final vegetative performance standard will be the survival of 210 planted stems per acre in the planted riparian areas at the end of the required seven-year monitoring period. The interim measure of vegetative success for the Site will be the survival of at least 320 planted stems per acre at the end of MY3 and at least 260 stems per acre at the end of MY5. In NC Mountain counties, planted trees must average 6 feet in height in each plot at the end of the fifth year of monitoring and 8 feet in height at Year 7. The extent of invasive species coverage will also be monitored and controlled as necessary throughout the required monitoring period.

2.4 Visual Assessments

Visual monitoring should support the specific performance standards for each metric as described above.

2.5 Schedule and Reporting

Monitoring reports will be prepared in the fall of each year of monitoring and submitted to DMS. Based on the DMS Annual Monitoring Template (June 2017), the monitoring reports will include the following:

- Project background which includes project objectives, project structure, restoration type and approach, location and setting, history and background,
- Project Asset Map of major project elements,
- Photographs showing views of the restored Site taken from fixed point stations,
- Current Condition Plan View Map with monitoring features and current problem areas noted such as stability and easement encroachment based on the cross-section surveys and annual visual assessments,
- Assessment of the stability of the stream based on the cross-sections,

- Vegetative data as described above including the identification of any invasion by undesirable plant species,
- A description of damage by animals or vandalism,
- Maintenance issues and recommended remediation measures will be detailed and documented, and
- Wildlife observations.

Section 3: MONITORING PLAN & METHODOLOGY

Annual monitoring will consist of collecting morphologic, vegetative, and hydrologic data to assess the project success based on the restoration goals, as outlined in the Shake Rag Mitigation Site Mitigation Plan (2019). Monitoring requirements will follow guidelines outlined in the DMS Annual Monitoring and Closeout Reporting Template (June 2017) and the USACE Stream and Wetland Mitigation Guidance (October 2016). Installed monitoring device and plot locations closely mimic the locations of those proposed in the Site's Mitigation Plan. Deviations from these locations were made when professional judgement deemed them necessary to better represent as-built field conditions or when installation of the device in the proposed location was not physically feasible. Project success will be assessed by measuring channel dimension, substrate composition, vegetation, surface water hydrology, and by analyzing photographs and performing visual assessments. Any high priority problem areas identified, such as unstable stream banks, bed instability, aggradation/degradation, or poor vegetation establishment will be evaluated on a case-by-case basis. The problem areas will be visually noted and reported to DMS staff in the annual report.

Refer to Table 5 Figures 3.0 through 3.4 in Appendix 1 for the monitoring component summary and for monitoring locations discussed below.

3.1 Stream Morphological Parameters and Channel Stability

Geomorphic assessments follow guidelines outlined in the Stream Channel Reference Sites: An Illustrated Guide to Field Techniques (Harrelson et al., 1994), methodologies utilized in the Rosgen stream assessment and classification documents (Rosgen, 1994 and 1996), and in the Stream Restoration: A Natural Channel Design Handbook (Doll et al., 2003).

3.1.1 Dimension

To assess channel dimension performance, 13 permanent cross-sections were installed along stream restoration and enhancement 1 reaches to represent approximately 50% riffles and 50% pools and as defined in Table 22 and Table 23 of the Mitigation Plan. Cross-section locations were chosen in the field to be representative of the typical dimensions for each project reach. Each cross-section is permanently marked with rebar installed in concrete and ½ inch PVC pipes. Cross-section surveys will include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg. Cross-section surveys will be conducted in monitoring years one, two, three, five, and seven. Photographs will be taken of the cross-sections looking upstream and downstream during the survey assessment.

3.1.2 Pattern and Profile

Longitudinal profile surveys will not be conducted during the seven-year post-construction monitoring period unless other indicators during the annual monitoring indicate a trend toward vertical and lateral instability. If a longitudinal profile is deemed necessary, monitoring will follow standards as described in the DMS Annual Monitoring and Closeout Reporting Template (June 2017), and the Stream Mitigation Guidelines issued in October 2016 by the USACE for the necessary reaches. Stream pattern and profile will be assessed visually as described below in Section 3.1.6.

3.1.3 Substrate

Reach-wide pebble count will be performed in each restoration reach for classification purposes and will be conducted in monitoring years one, two, three, five, and seven. Riffle 100-count substrate sampling will be collected during the baseline monitoring only to characterize pavement at as-built.

3.1.4 Photo Reference Points

A total of 30 permanent photograph reference points were established along the stream reaches after construction. Photographs will be taken once a year to visually document stability for the seven-year monitoring period. Permanent markers were established and located with GPS equipment so that the same locations and view directions on the site are photographed each year. Photos will be used to monitor all stream reaches.

Longitudinal reference photos were established approximately every 300-500 LF along the channel by taking a photo looking upstream and downstream. Cross-sectional photos will be taken of each permanent cross-section looking upstream and downstream.

3.1.5 Visual Assessment

Visual assessments will be performed along stream reaches on a semi-annual basis during the seven-year monitoring period. Areas of concern, such as channel instability (i.e. lateral and/or vertical instability, in-stream structure failure/instability and/or piping, headcuts), vegetation health (i.e. low stem density, mortality, invasive species, and/or encroachment), beaver activity, or livestock trespass will be mapped, photographed, and described in the annual monitoring reports. Problem areas will be re-evaluated during each subsequent visual assessment. Should remedial actions be required, recommendations will be provided in the annual monitoring report.

3.2 Hydrology Documentation

Automated pressure transducers will document stream hydrology and will be used on mitigation reaches that implement restoration and/or enhancement level I approaches throughout the seven-year monitoring period. Henceforth, these devices will be referred to as “crest gages (CG)” for those recording bankfull events and “stream gages (SG)” for those recording baseflow.

3.2.1 Bankfull Events

The occurrence of bankfull events will be documented with the use of automated CGs, photographs, and visual assessments such as debris lines. CGs will be set to record bank full events every three hours and will be installed within the stream’s surveyed riffle cross section. A total of 5 CGs were installed along restoration and enhancement I reaches. The CGs will be downloaded semi-annually to determine if a bankfull event has occurred. Photographs will be used to document the occurrence of debris lines and sediment deposition observed during field visits.

3.2.2 Baseflow Monitoring

Streamflow stage will be monitored to document 30 days of continuous flow using a continuous stage recorder or SG. An automated SG was installed within the upper third of UT8 and will be set to record every 2 hours. Evidence of channel flow will be documented with a photo when possible. Transducer data will be plotted and included in the annual monitoring reports.

3.3 Vegetation

Vegetative plot monitoring will be conducted in post-construction monitoring years 1, 2, 3, 5, and 7. Permanent plots will be monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008) and the 2016 USACE Stream and Wetland Mitigation Guidance to assess the vegetation success. For both permanent and random plots, all woody stems, including exotic and invasive species, should be counted. Supplemental plantings and volunteer plants must be present for at least two growing seasons before counting toward performance standards for monitoring years five and seven. Exotic/invasive species will not count toward success of performance standards.

A total of 5 permanent vegetation plots were established within the project easement area. Permanent vegetation plots were randomly established within the planted stream riparian buffer areas to capture the heterogeneity of the designed vegetative communities. The locations of permanent vegetation plots were chosen in the field using the same distribution throughout the planting areas, as shown in the Site's Mitigation Plan, and to best represent the planted areas within the easement. All of the plots were established as either a standard 10 meter by 10 meter square plot or a 5 meter by 20 meter plot. The vegetation plot corners have been marked and are recoverable either through field identification or with the use of a GPS unit. Reference photographs at the origin looking diagonally across the plot to the opposite corner were taken during the MY0 in January 2020. Subsequent assessments in monitoring years one, two, three, five, and seven following baseline survey will capture the same reference photograph locations.

Individual permanent plot data will be provided and will include diameter, height, density, vigor, damage (if any), and percent survival. Planted woody stems will be marked during assessment as needed based on a known origin so they can be found in succeeding monitoring years. Mortality will be determined from the difference between the baseline year's living planted stems and the current year's living planted stems.

To evaluate random vegetation performance for the Site, 4 mobile vegetation plots were established in MY0, for use in MY1, using a circular or 100 m^2 square/rectangular plot. Mobile plots will be reestablished in different and random locations throughout the planted conservation easement in monitoring years 2, 3, 5, and 7. These locations will be geographically recorded and depicted in the CCPV maps for the corresponding monitoring assessment year. Mobile vegetation plot assessments will document the number of stems, species type, and stem height within the plot.

Please refer to Figures 3.0 through 3.4 in Appendix 1 for the permanent and mobile vegetation monitoring locations.

Section 4: ADAPTIVE MANAGEMENT AND CONTINGENCY PLAN

4.1 Adaptive Management Plan

Wildlands will perform maintenance as needed on the mitigation project. A physical inspection of the Site shall be conducted a minimum of once per year throughout the post-construction monitoring period or until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance for stream features should be expected most often in the first two years following site construction. The need for maintenance will be evaluated annually during monitoring activities. Maintenance activities may include the following.

Component/ Feature	Maintenance through project close-out
Stream	Routine channel maintenance and repair activities may include chinking of in-stream structures to prevent piping, securing of loose coir matting, and supplemental installations of live stakes and other target vegetation along the channel – these shall be conducted where success criteria are threatened or at the discretion of the Designer. Areas where storm water and floodplain flows intercept the channel may also require maintenance to prevent bank failures and head-cutting. Beaver activity will be monitored and beaver dams on project streams will typically be removed, at the discretion of the Designer, during the monitoring period to allow for bank stabilization and stream development outside of this type of influence.
Vegetation	Vegetation shall be maintained to ensure the health and vigor of the targeted community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, mulching, and fertilizing. Exotic invasive plant species requiring treatment per the Invasive Species Treatment Plan (Appendix 7 of the Shake Rag Mitigation Plan) shall be treated in accordance with that plan and with NC Department of Agriculture (NCDA) rules and regulations.
Site Boundary	Site boundaries shall be identified in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, tree-blazing, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as-needed basis.

The Wildlands Team will develop necessary adaptive measures or implement appropriate remedial actions in the event that the Site or a specific component of the Site fails to achieve the success criteria outlined above. The project-specific monitoring plan developed during the design phase identifies an appropriate threshold for maintenance intervention based on the monitored items. Any actions implemented will be designed to achieve the success criteria specified previously and will include a work schedule and updated monitoring criteria.

Section 5: AS-BUILT CONDITION (BASELINE)

The Site construction and as-built surveys were completed in February 2020. The survey included developing an as-built topographic surface, locating the channel boundaries, structures, and cross-sections. For comparison purposes, during the baseline assessments, reaches were divided into assessment reaches in the same way that they were established for design parameters: Shake Rag Branch Reaches 1 through 5, UT1 Reaches 1 and 2, UT1a, UT2 Reaches 1 and 2, UT3 Reaches 1 and 2, UT4, UT5, UT6, UT7, and UT8 .

5.1 Record Drawings

A sealed half-size record drawing is located in Appendix 4 that includes redlines for any significant field adjustments made during construction that were different from the design plans. Specific changes by each project area are detailed below.

5.1.1 Shake Rag Branch

- Station 908+75 – 909+21: 46 LF of restoration replaced with enhancement II. After debris removal, streambed was reworked by hand to create a stable low-flow channel.
- Station 909+21: Reach break moved from station 908+75 to 909+21 to account for restoration starting 46 LF down-stream.
- Station 909+21 – 909+51: 30 LF of stream was re-aligned from the original design to an alternate alignment to account for field conditions and to tie the restored channel to the existing channel.
- Station 921+50: Brush toe was not installed to reduce disturbance to steep right bank.
- Station 926+48: Rock sill was not constructed. The profile tied out to existing thalweg before rock sill location.
- Station 930+60: Brush toe was not installed due to lack of material.
- Station 931+13: Brush toe not installed due to lack of material.

5.1.2 UT1

- Station 111+18: 63 LF of stream was re-aligned from the original design to an alternate alignment to save tree roots.
- Station 112+25: Lunker log was not constructed to reduce disturbance to left bank.
- Station 112+87: Lunker log was not constructed to maintain existing stable flood bench.

5.1.3 UT3

- Station 304+26 -305+02: To save trees, 76 LF of the design channel was re-aligned and resulted in 77 LF constructed channel.
- Station 304+98: Lunker log was not constructed due to the change in alignment.
- Station 312+45: Brush toe was not installed due to lack of material.
- Station 314+70: Brush toe was not installed to reduce disturbance to steep right bank.

5.1.4 UT4

- Station 400+04: Rock step added to stream profile to improve tie in between BMP and channel bed.

- Station 403+48: Brush toe was not installed due to lack of material.
- Station 407+27: Lunker log was not constructed due to lack of material.

5.1.5 Vegetation Planting Plan

- Open Areas – Trees: Black cherry (*Prunus serotina*) and sweet birch (*Betula lenta*) were replaced with white oak (*Quercus alba*). No alternates were used.
- Open Areas – Small trees/shrubs: Tag alder (*Alnus serrulata*), witch hazel (*Hamamelis virginiana*), flowering dogwood (*Cornus florida*), spicebush (*Lindera benzoin*), and serviceberry (*Amelanchier arborea*) were replaced with possumhaw (*Ilex decidua*), swamp rose (*Rosa palustris*), and sourwood (*Oxydendrum arboreum*).
- Partially Vegetated Areas – Trees: Black cherry (*Prunus serotina*) and sweet birch (*Betula lenta*) were replaced with white oak (*Quercus alba*) and American beech (*Fagus grandifolia*). No alternates were used.
- Partially Vegetated Areas – Small trees/shrubs: Flowering dogwood (*Cornus florida*) and painted buckeye were replaced with highbush blueberry (*Vaccinium corymbosum*), sourwood (*Oxydendrum arboreum*), Eastern sweetshrub (*Calycanthus floridus*), and American holly (*Ilex opaca*). Alternate Eastern hophornbeam (*Ostrya virginiana*) was planted.
- Riparian Corridor – Live stakes: Elderberry (*Sambucus canadensis*) was not planted.
- Riparian Corridor – Herbaceous plugs: Lurid sedge (*Carex lurida*) and woolgrass (*Scirpus cyperinus*) were replaced with switchgrass (*Panicum virgatum*), marsh hibiscus (*Hibiscus moscheutos*), Southern blue flag (*Iris virginica*), cardinal flower (*Lobelia cardinalis*), and swamp sunflower (*Helianthus angustifolius*).

5.2 Baseline Data Assessment

MY0 was conducted between December 2019 and March 2020 with the vegetation data collection occurring in January 2020, immediately following planting. The first annual monitoring assessment (MY1) will be completed in the fall of 2020. The Site will be monitored for a total of seven years, with the final monitoring activities scheduled for 2026.

5.2.1 Morphological State of the Channel

As-built morphological data collection was conducted between December 2019 to February 2020. Please refer to Appendix 2 for summary data tables, morphological plots, and stream photographs.

Profile

The MY0 profiles generally match the profile design parameters. On the design profiles, riffles were depicted as straight lines with consistent slopes. Variations from the design profile reflect field changes during construction as a result of field conditions. Additionally, some of the as-built riffle slopes were steeper than the design parameters for Shake Rag Branch Reach 3, UT2 Reach 2, and UT3 Reach 2. Variations in channel profile do not constitute a problem or indicate a need for remedial actions and will be assessed visually during the CCPV Site walks.

Dimension

Generally, as-built cross-sectional dimensions closely mimic design parameters with minor variations. Noted differences include as-built entrenchment ratios for UT8 and Shake Rag Branch Reach 5 which exceed design parameters reflecting wider floodprone widths in the landscape. In addition, the as-built max bankfull depth for Shake Rag Reach 4 is slightly shallower than the design parameters; however, the

width/depth ratio is still appropriate for the channel type. For UT2 Reach 2, the as-built bankfull width is narrower than design parameters since sod mats were used extensively in this reach resulting in some variations in bankfull widths. Over time as vegetation is established, the channels may narrow. This narrowing over time would not be seen as an indicator of instability in and of itself.

Pattern

All project streams are either Rosgen A-type or B-type stream and pattern data is not applicable for high gradient channels.

Bankfull Events

Bankfull events recorded following completion of construction will be reported in the Year 1 monitoring report.

5.2.2 Vegetation

The MY0 planted density is 607 stems/acre for permanent vegetation plots and 546 stems/acre for mobile vegetation plots. The total overall planted density representative for the site is 580 stems/acre, which exceeds the interim measure of vegetative success of at least 320 planted stems per acre at the end of the third monitoring year. Summary data and photographs of each plot can be found in Appendix 3.

Section 6: REFERENCES

Doll, B.A., Grabow, G.L., Hall, K.A., Halley, J., Harman, W.A., Jennings, G.D., and Wise, D.E. 2003. Stream Restoration A Natural Channel Design Handbook.

Harrelson, Cheryl C; Rawlins, C.L.; Potyondy, John P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique.* Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Lee, Michael T., Peet, Robert K., Steven D., Wentworth, Thomas R. 2008. CVS-EEP Protocol for Recording Vegetation Version 4.2. Retrieved from: http://cvs.bio.unc.edu/protocol/cvs-eep-protocol-v4.2-lev1-2.pdf North Carolina Division of Mitigation Services. 2009. French Broad River Basin Restoration Priorities.

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United States Army Corps of Engineers (USACE), October 2016. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.

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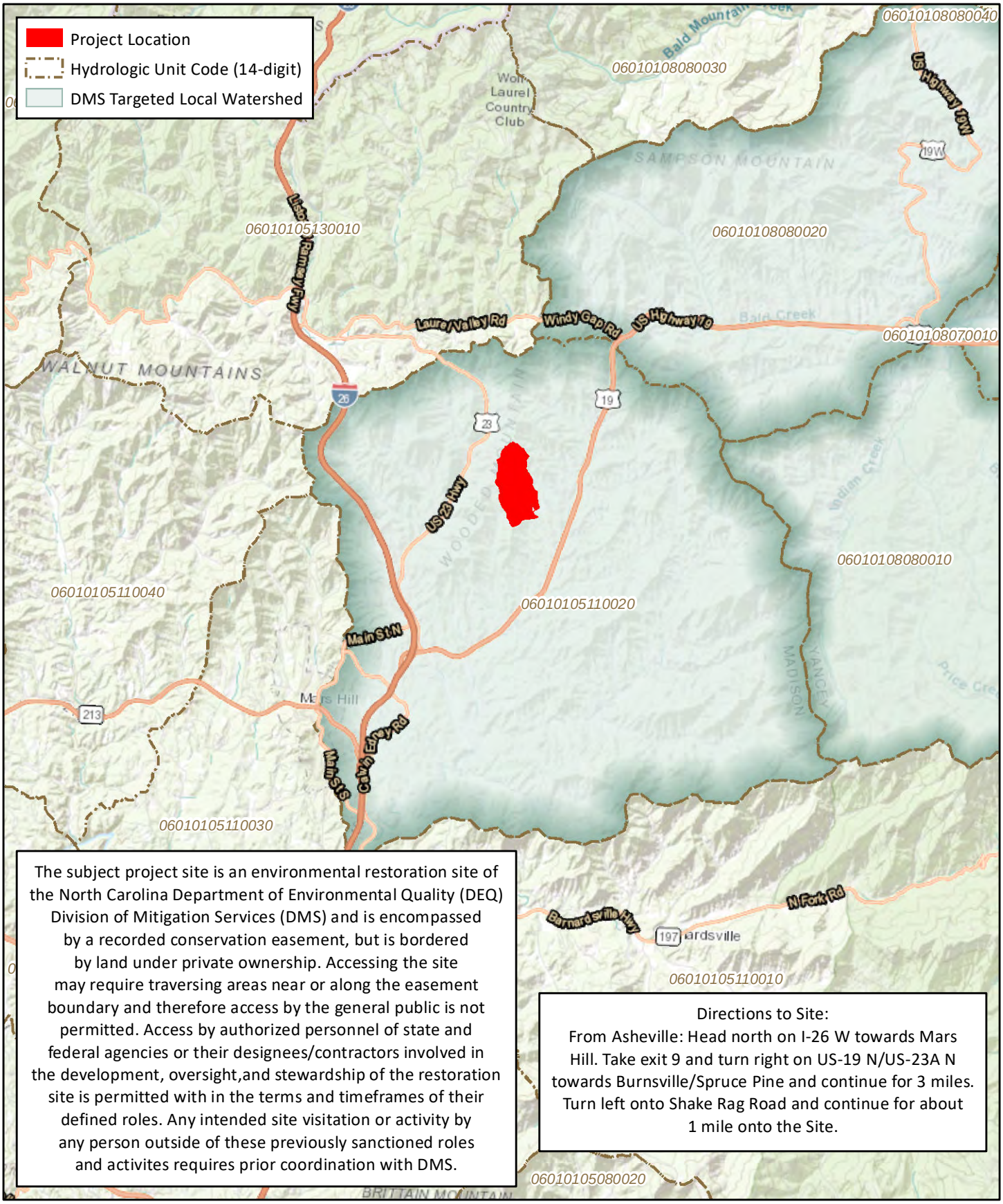
APPENDIX 1. General Figures and Tables



The subject project site is an environmental restoration site of the North Carolina Department of Environmental Quality (DEQ) Division of Mitigation Services (DMS) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight,and stewardship of the restoration site is permitted with in the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activites requires prior coordination with DMS.

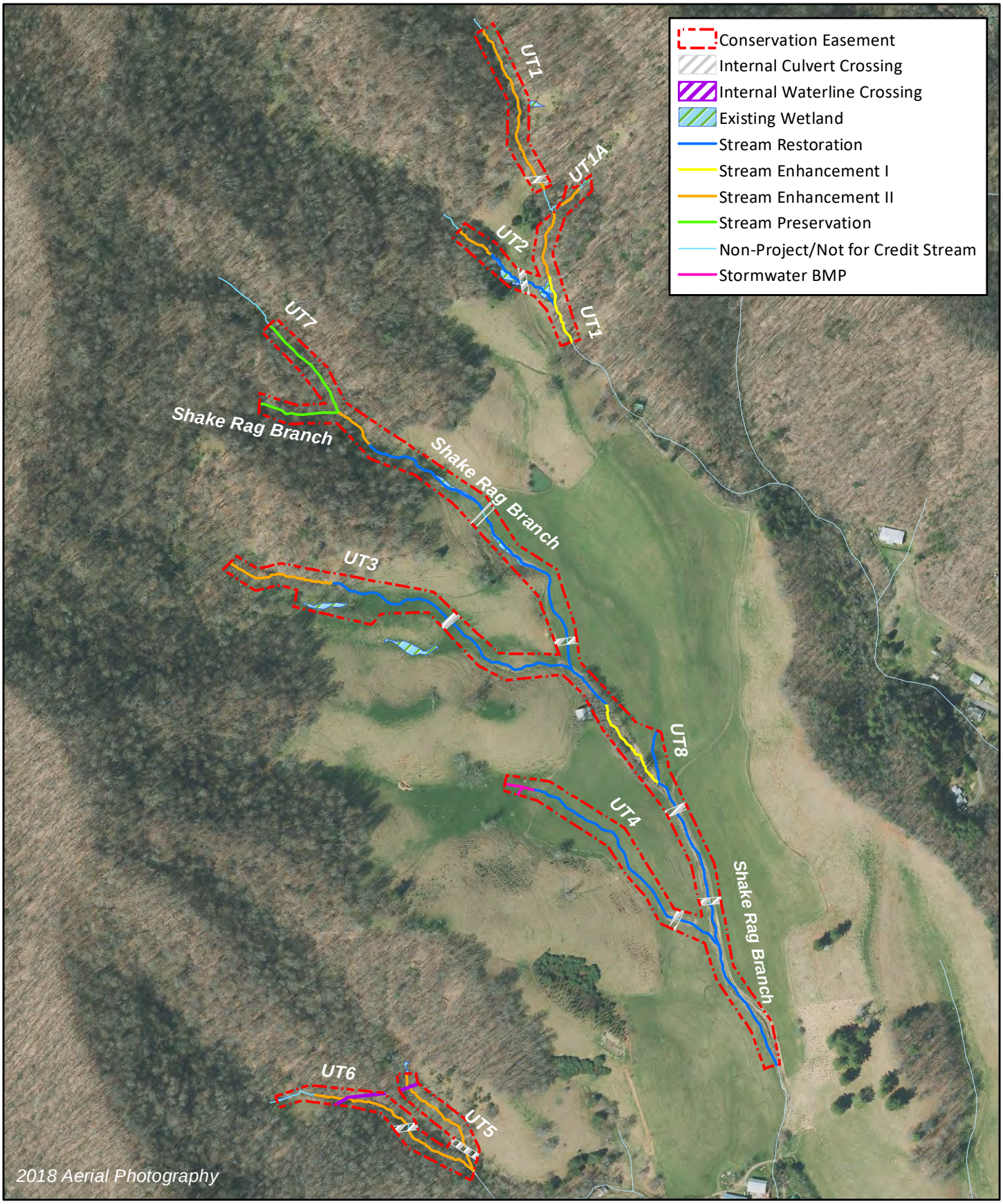
Directions to Site:
From Asheville: Head north on I-26 W towards Mars Hill. Take exit 9 and turn right on US-19 N/US-23A N towards Burnsville/Spruce Pine and continue for 3 miles. Turn left onto Shake Rag Road and continue for about 1 mile onto the Site.

WILDLANDS ENGINEERING

0 1 2 Miles

N

Figure 1 Project Vicinity Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020
Madison County, NC



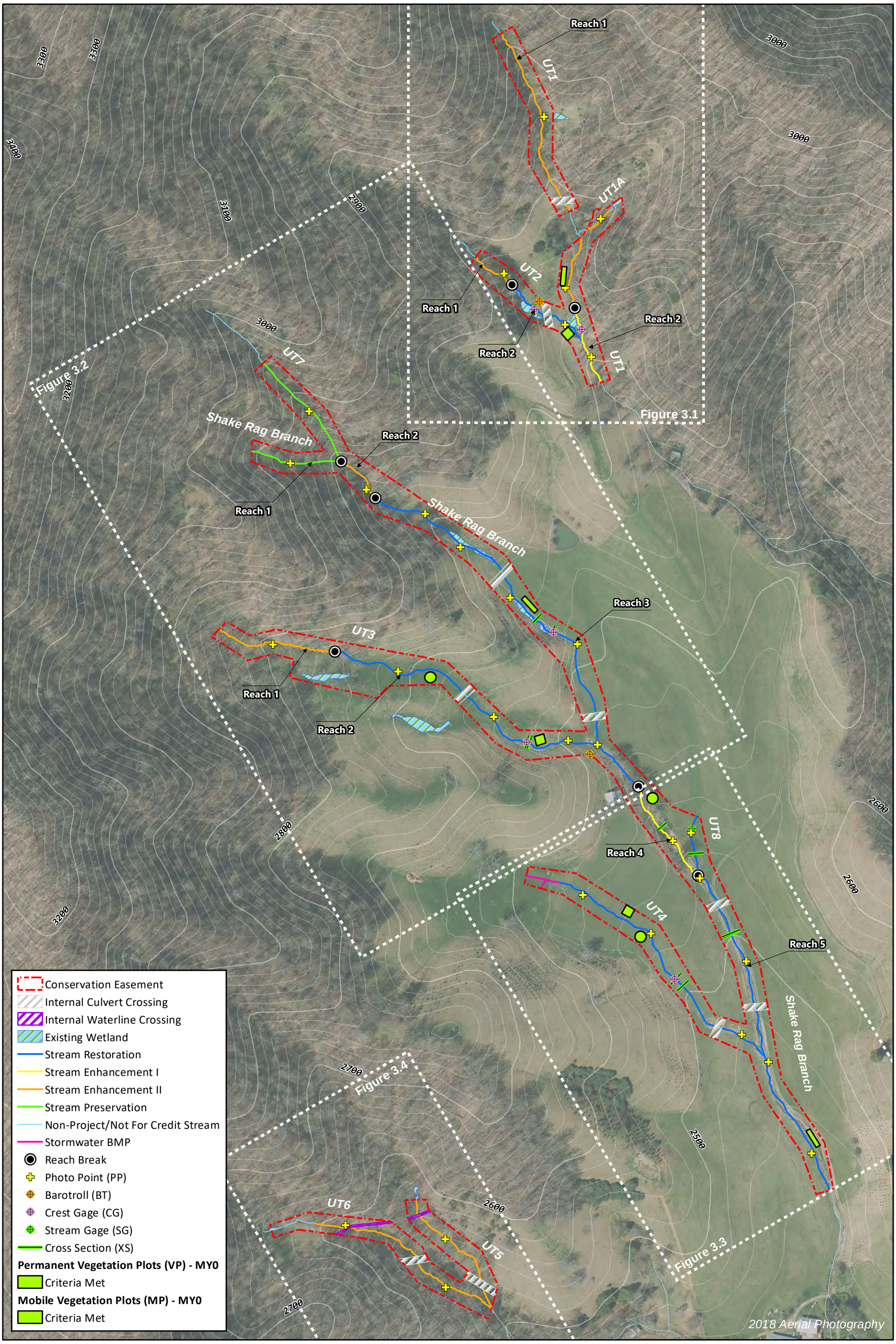
WILDLANDS ENGINEERING

0 250 500 Feet

N

Figure 2 Project Component/Asset Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Madison County, NC



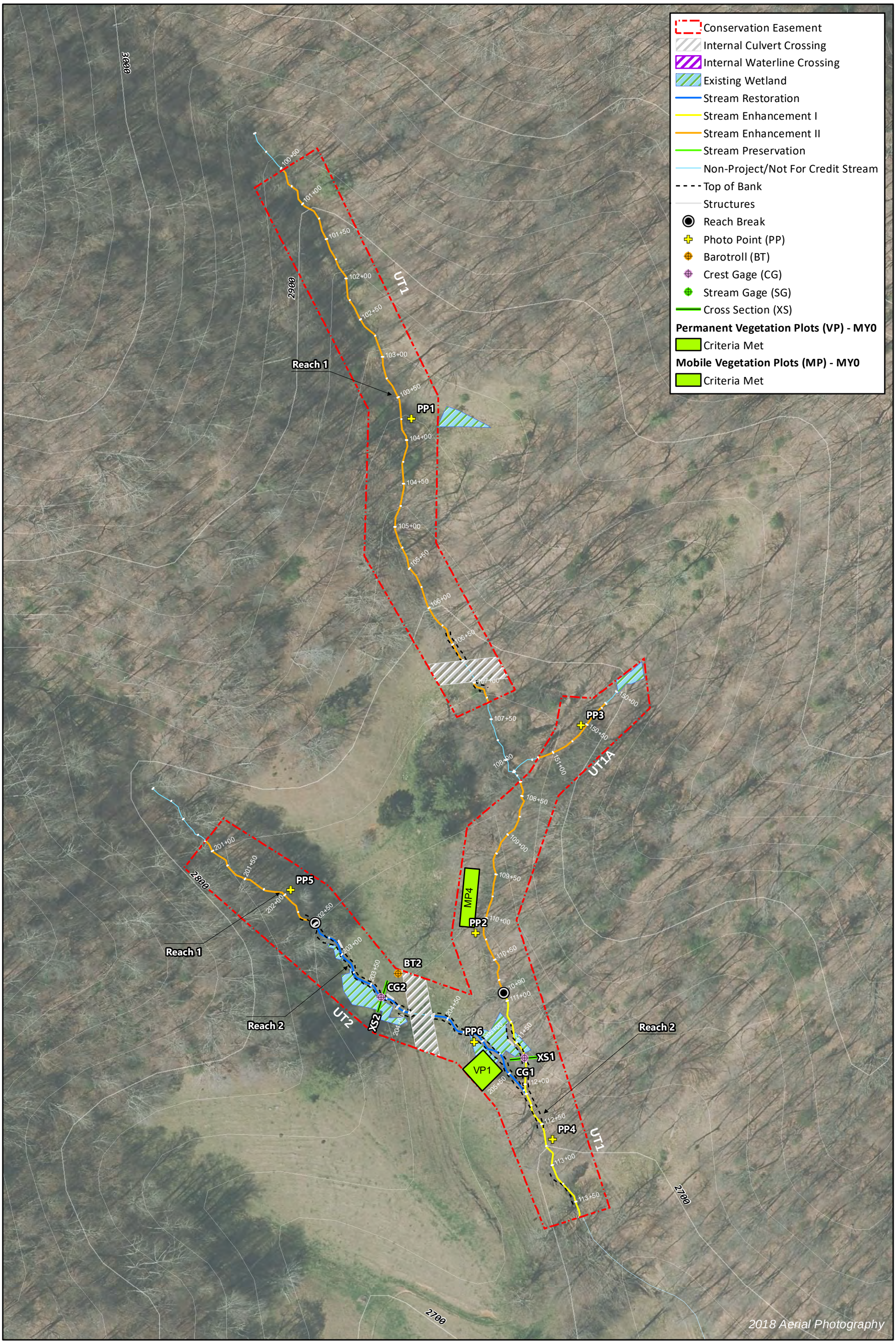
WILDLANDS ENGINEERING

0 300 600 Feet

N

Figure 3.0 Monitoring Plan View Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Madison County, NC



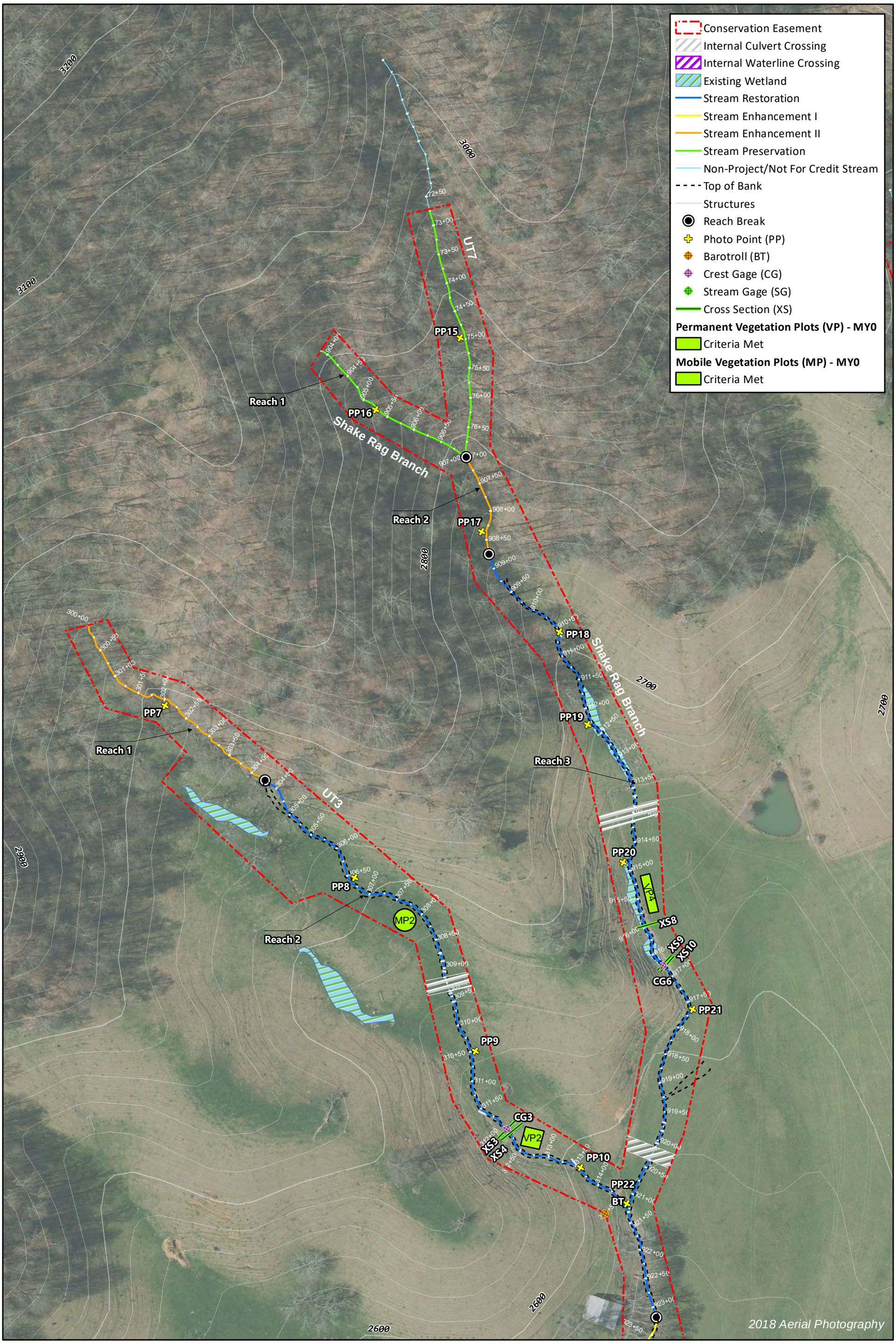
WILDLANDS ENGINEERING

0 100 200 Feet

N

Figure 3.1 Monitoring Plan View Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Madison County, NC

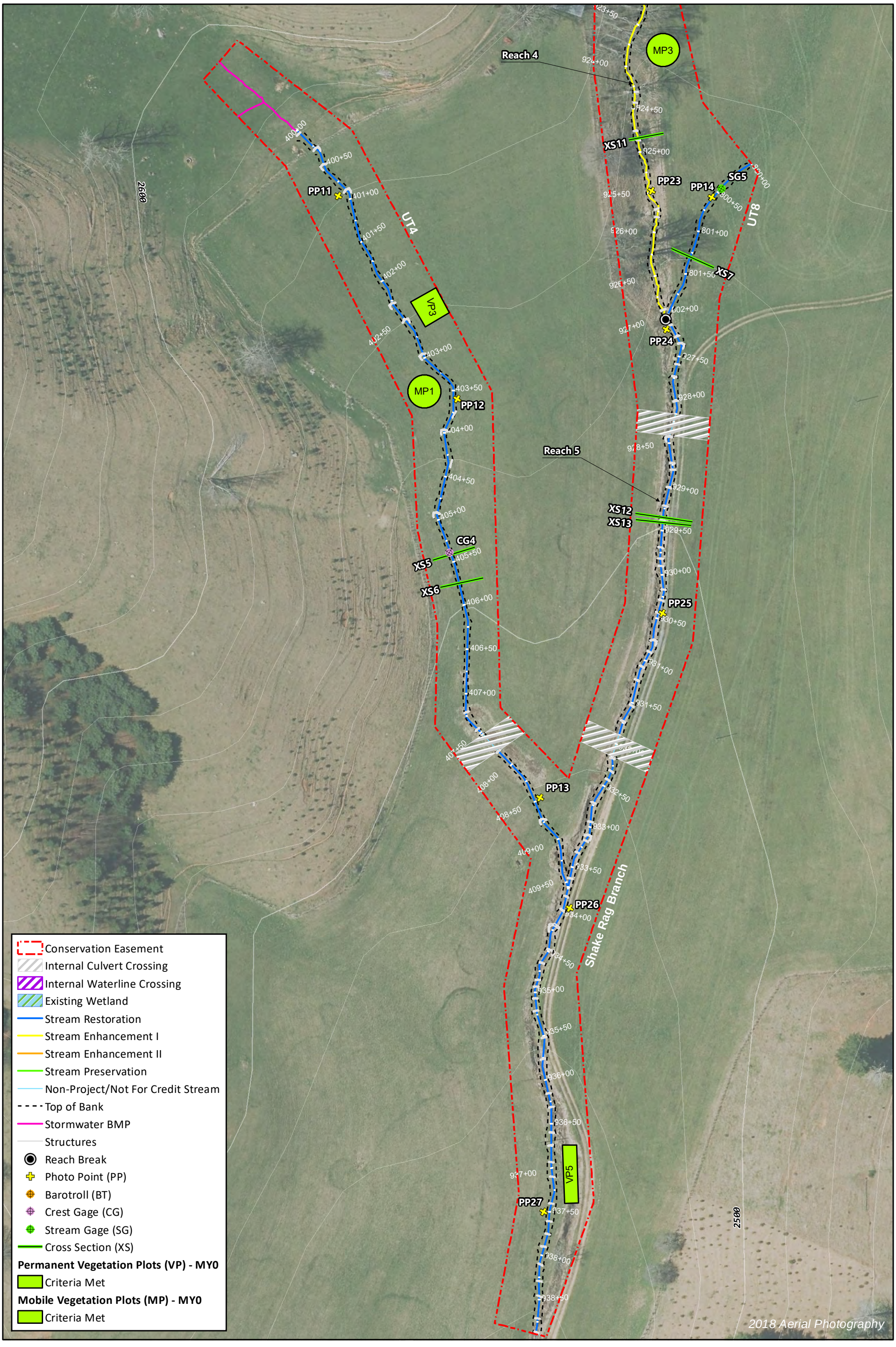


WILDLANDS ENGINEERING

0 150 300 Feet

Figure 3.2 Monitoring Plan View Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Madison County, NC

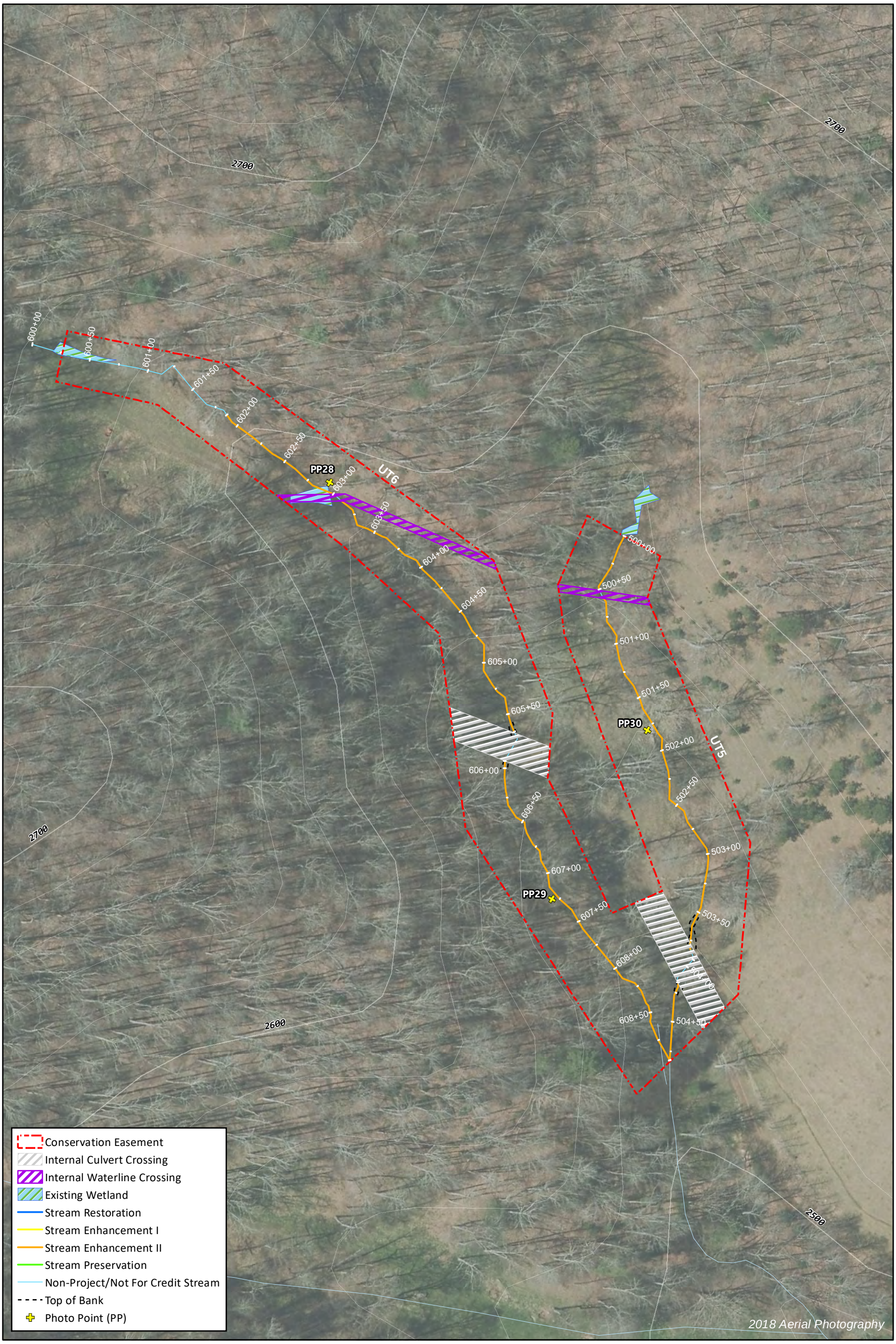


WILDLANDS ENGINEERING

0 100 200 Feet

Figure 3.3 Monitoring Plan View Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Madison County, NC



WILDLANDS ENGINEERING

0 75 150 Feet

Figure 3.4 Monitoring Plan View Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020
Madison County, NC

Table 1. Mitigation Assets and Components

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Project Components								
Project Area/Reach	**Existing Footage (LF) or Acreage[1]**	**Mitigation Plan Footage/ Acreage**	**Mitigation Category**	**Restoration Level**	**Priority Level**	**Mitigation Ratio (X:1)**	**As-Built Footage/ Acreage[2]**	**Comments**
Shake Rag Branch R1	312	312	Cold	Preservation	N/A	10.000	312	N/A
Shake Rag Branch R2	175	175	Cold	Enhancement II	N/A	2.500	175	N/A
Shake Rag Branch R3	1,451	1,393	Cold	Restoration	P1	1.000	1,391	N/A
Shake Rag Branch R4	385	385	Cold	Enhancement I	N/A	1.500	385	N/A
Shake Rag Branch R5	1,216	1,134	Cold	Restoration	P1, P2	1.000	1,134	N/A
UT1 R1	934	907	Cold	Enhancement II	N/A	2.500	907	N/A
UT1 R2	255	278	Cold	Enhancement I	N/A	1.500	278	N/A
UT1A	100	100	Cold	Enhancement II	N/A	2.500	100	N/A
UT2 R1	164	164	Cold	Enhancement II	N/A	2.500	164	N/A
UT2 R2	296	304	Cold	Restoration	P1	1.000	304	N/A
UT3 R1	426	426	Cold	Enhancement II	N/A	2.500	426	N/A
UT3 R2	1,387	1,019	Cold	Restoration	P1	1.000	1,019	N/A
UT4	910	930	Cold	Restoration	P1	1.000	930	N/A
UT5	483	439	Cold	Enhancement II	N/A	2.500	444	N/A
UT6	707	673	Cold	Enhancement II	N/A	2.500	670	N/A
UT7	428	428	Cold	Preservation	N/A	10.000	428	N/A
UT8	210	206	Cold	Restoration	P1	1.000	206	N/A

Project Credits							
Restoration Level	**Stream**			**Riparian Wetland**		**Non-Riparian Wetland**	**Coastal Marsh**
	Warm	**Cool**	**Cold**	**Riverine**	**Non-Riv**		
Restoration	N/A	N/A	4,986.000	N/A	N/A	N/A	N/A
Re-establishment				N/A	N/A	N/A	N/A
Rehabilitation				N/A	N/A	N/A	N/A
Enhancement				N/A	N/A	N/A	N/A
Enhancement I	N/A	N/A	442.000				
Enhancement II	N/A	N/A	1,153.600				
Creation				N/A	N/A	N/A	N/A
Preservation	N/A	N/A	74.000	N/A	N/A	N/A	
Totals	**N/A**	**N/A**	**6,655.600**	**N/A**	**N/A**	**N/A**	**N/A**

Notes:

1. Some or all of SRB Reach 3, UT3 Reach 2, UT4, and UT8 were previously buried in rock-lined channels or pipes. Reported exiting lengths are estimates based upon land owner communication, remote sensing, and field verification to approximate the subsurface location and alignment.

2. The Site contains 12 internal easement crossings. This value excludes the affected length of proposed stream centerline within each crossing.

Table 2. Project Activity and Reporting History

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Activity or Report		Data Collection Complete	Completion or Delivery
Institution Date		N/A	May 2017
404 Permit		June 2019	June 2019
Mitigation Plan		February - October 2018	March 2019
Final Design - Construction Plans		June 2019	June 2019
Construction		July 2019 - January 2020	January 2020
Bare root and live stake plantings for reach/segments		December 2020	December 2020
Baseline Monitoring Document (Year 0)		December 2019 - March 2020	April 2020
Year 1 Monitoring	Stream Survey		
	Vegetation Survey		
Year 2 Monitoring	Stream Survey		
	Vegetation Survey		
Year 3 Monitoring	Stream Survey		
	Vegetation Survey		
Year 4 Monitoring	Stream Survey		
	Vegetation Survey		
Year 5 Monitoring	Stream Survey		
	Vegetation Survey		
Year 6 Monitoring	Stream Survey		
	Vegetation Survey		
Year 7 Monitoring	Stream Survey		
	Vegetation Survey		

Table 3. Project Contact Table

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Designers Jake McLean, PE, CFM	**Wildlands Engineering, Inc.** 1430 South Mint Street, Suite 104 Charlotte, NC 28203 704.332.7754
Construction Contractors	**Baker Grading & Landscaping, Inc.** 1000 Bat Cave Road Old Fort, NC 28762
Planting Contractor	**Bruton Natural Systems, Inc.** PO Box 1197 Freemont, NC 27830
Seeding Contractor	**Baker Grading & Landscaping, Inc.**
Seed Mix Sources	**Baker Grading & Landscaping, Inc.**
Nursery Stock Suppliers Bare Roots Live Stakes Herbaceous Plugs	**Bruton Natural Systems, Inc.**
Monitoring Performers Monitoring, POC	**Wildlands Engineering, Inc.** Kristi Suggs 704.332.7754 Ext. 110

Table 4. Project Information and Attributes
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Project Information	
Project Name	Shake Rag Mitigation Site
	Madison County
Project Area (acres)	18.000
Project Coordinates (latitude and longitude)	35° 52' 41"N 82° 29' 47"W
Planted Acreage (Acre of Woody Stems Planted)	9.5
Project Watershed Summary Information	
Physiographic Province	Blue Ridge
River Basin	French Broad
USGS Hydrologic Unit 8-digit	06010105
USGS Hydrologic Unit 14-digit	06010105110020
DWR Sub-basin	04-03-04
Project Drainage Area (acres)	70 (UT1), 163 (Shake Rag Branch), 43 (UT6)
Project Drainage Area Percentage of Impervious Area	<1% (UT1), <1% (Shake Rag Branch), <1% (UT6)
2011 NLCD Land Use Classification	UT1: Forest (95%),Pasture/Hay (5%), Shrubland (0%), Urban (0%) Shake Rag Branch: Forest (49%), Pasture/Hay (49%), Shrubland (1%), Urban (1%) UT6: Forest (99%), Pasture/Hay (1%), Shrubland (0%), Urban (0%)

Reach Summary Information

Parameters	Shake Rag Branch					UT3		UT4	UT7	UT8
	R1	R2	R3	R4	R5	R1	R2			
Length of reach (linear feet) - Post-Restoration	312	175	1,391	385	1,134	426	1,019	930	428	206
Valley confinement (Confined, moderately confined, unconfined)	Confined	Moderately confined				Confined	Confined	N/A	Confined	N/A
Drainage area (acres)	10	26	76	77	163	12	38	32	13	19
Perennial, Intermittent, Ephemeral	P	P	P	P	P	P	P	P	P	P
NCDWR Water Quality Classification	WS-II; HQW									
Morphological Description (stream type) - Pre-Restoration	-	A4a+	A4a+	A4/B4a	A4	A4a+/B4a	A4a+	-	-	-
Morphological Description (stream type) - Post-Restoration	-	A4a+	A4a+/B4a	A4/B4a	A4/B4a	A4a+/B4a	A4a+/B4a	A4a+/B4a	-	A4/B4a
Evolutionary trend (Simon's Model) - Pre- Restoration	I	VI	II/III	V/VI	III/IV/V	VI	II/III/IV	II	I	II
FEMA classification	None									

Parameters	UT1		UT1A	UT2		UT5	UT6
	R1	R2		R1	R2		
Length of reach (linear feet) - Post-Restoration	907	278	100	164	304	444	670
Valley confinement (Confined, moderately confined, unconfined)	Confined	Moderately confined	Confined	Moderately Confined	Confined	Moderately confined	Moderately confined
Drainage area (acres)	38	70	6	29	31	18	25
Perennial, Intermittent, Ephemeral	P	P	P	P	P	P	P
NCDWR Water Quality Classification	WS-II; HQW						
Morphological Description (stream type) - Pre-Restoration	A4a+	A4a+	A4a+	A4a+/B4a	A4a+	B4a	B4a
Morphological Description (stream type) - Post-Restoration	A4a+	A4a+/B4a	A4a+	A4a+/B4a	A4a+/B4a	B4a	B4a
Evolutionary trend (Simon's Model) - Pre- Restoration	VI	V/VI	I	VI	II/III	VI	VI
FEMA classification	None						

Regulatory Considerations

Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the United States - Section 404	Yes	Yes	USACE Action ID# SAW-2017-00100
Waters of the United States - Section 401	Yes	Yes	DWR# 17-1157
Division of Land Quality (Erosion and Sediment Control)	Yes	Yes	NPDES Construction Stormwater General Permit NCG010000
Endangered Species Act	Yes	Yes	Categorical Exclusion Document in Mitigation Plan
Historic Preservation Act	Yes	Yes	Categorical Exclusion Document in Mitigation Plan
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	No	N/A	N/A
Essential Fisheries Habitat	No	N/A	N/A

Table 5a. Monitoring Component Summary

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Shake Rag Branch, UT3, UT4, UT8, and UT7

Parameter	Monitoring Feature	Quantity / Length by Reach										Frequency	Notes
		Shake Rag Reach 1	Shake Rag Reach 2	Shake Rag Reach 3	Shake Rag Reach 4	Shake Rag Reach 5	UT3 Reach 1	UT3 Reach 2	UT4	UT8	UT7		
Dimension	Riffle Cross-Section	N/A	N/A	2	1	1	N/A	1	1	1	N/A	Year 1, 2, 3, 5, and 7	1
	Pool Cross-Section	N/A	N/A	1	0	1	N/A	1	1	0	N/A		
Pattern	Pattern	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2
Profile	Longitudinal Profile	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Substrate	Reach Wide (RW) Pebble Count	N/A	N/A	1 RW	1 RW	1 RW	N/A	1 RW	1 RW	1 RW	N/A	Year 1, 2, 3, 5, and 7	3
Hydrology	Crest Gage (CG) and or/Stream Gage (SG)	N/A	N/A	1 CG			N/A	1 CG	1 CG	1 SG	N/A	Semi-Annual	4
Vegetation	CVS Level 2/Mobile plots	N/A	7 (4 permanent, 3 mobile)								N/A	Year 1, 2, 3, 5, and 7	5
Visual Assessment		Yes										Semi-Annual	
Exotic and Nuisance Vegetation												Semi-Annual	6
Project Boundary												Semi-Annual	7
Reference Photos	Photographs	21										Annual	

Notes:

1. Cross-sections were permanently marked with rebar to establish location. Surveys include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg.

2. Pattern and profile will be assessed visually during semi-annual site visits. Longitudinal profile was collected during as-built baseline monitoring survey only, unless observations indicate widespread lack of vertical stability (greater than 10% of reach is affected) and profile survey is warranted in additional years to monitor adjustments or survey repair work.

3. Riffle 100-count substrate sampling were collected during the baseline monitoring only. A reachwide pebble count will be performed on each restoration or enhancement I reach during subsequent monitoring years for classification purposes only.

4. Crest gages and/or stream gages will be inspected and downloaded quarterly or semi-annually, evidence of bankfull events will be documented with a photo when possible. Transducers, if used, will be set to record stage once every 2 hours. The proposed gage on UT8 will be used for the sole purpose of documenting consecutive flow - an alternative proven method (e.g. game camera) may be used if agreed by IRT to be sufficient to demonstrate this requirement.

5. Both mobile and permanent vegetation plots will be utilized to evaluate the vegetation performance for 2% of the open areas planted acreage. Permanent vegetation monitoring plot assessments will follow CVS Level 2 protocols. Mobile vegetation monitoring plot assessments will document number of planted stems and species using a circular or 100 m2 square/rectangular plot. Planted shaded areas will be visually assessed.

6. Locations of exotic and nuisance vegetation will be mapped.
7. Locations of vegetation damage, boundary encroachments, etc. will be mapped.

Table 5b. Monitoring Component Summary

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT1, UT1A, UT2, UT5, and UT6

Parameter	Monitoring Feature	Quantity / Length by Reach							Frequency	Notes
		UT1 Reach 1	UT1 Reach 2	UT1A	UT2 Reach 1	UT2 Reach 2	UT5	UT6		
Dimension	Riffle Cross-Section	N/A	1	N/A	N/A	1	N/A	N/A	Year 1, 2, 3, 5, and 7	1
	Pool Cross-Section	N/A	0	N/A	N/A	0	N/A	N/A		
Pattern	Pattern	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2
Profile	Longitudinal Profile	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Substrate	Reach Wide (RW) Pebble Count	N/A	1 RW	N/A	N/A	1 RW	N/A	N/A	Year 1, 2, 3, 5, and 7	3
Stream Hydrology	Crest Gage (CG) and/or Stream Gage (SG)	N/A	1 CG	N/A	N/A	1 CG	N/A	N/A	Semi-Annual	4
Vegetation	CVS Level 2/Mobile Plots	2 (1 permanent, 1 mobile)					N/A	N/A	Year 1, 2, 3, 5, and 7	5
Visual Assessment		Yes							Semi-Annual	
Exotic and Nuisance Vegetation									Semi-Annual	6
Project Boundary									Semi-Annual	7
Reference Photos	Photographs	9							Annual	

Notes:

1. Cross-sections were permanently marked with rebar to establish location. Surveys include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg.

2. Pattern and profile will be assessed visually during semi-annual site visits. Longitudinal profile was collected during as-built baseline monitoring survey only, unless observations indicate widespread lack of vertical stability (greater than 10% of reach is affected) and profile survey is warranted in additional years to monitor adjustments or survey repair work.

3. Riffle 100-count substrate sampling were collected during the baseline monitoring only. A reachwide pebble count will be performed on each restoration or enhancement I reach during subsequent monitoring years for classification purposes only.

4. Crest gages and/or stream gages will be inspected and downloaded quarterly or semi-annually, evidence of bankfull events will be documented with a photo when possible. Transducers, if used, will be set to record stage once every 2 hours. The proposed gage on UT8 will be used for the sole purpose of documenting consecutive flow - an alternative proven method (e.g. game camera) may be used if agreed by IRT to be sufficient to demonstrate this requirement.

5. Both mobile and permanent vegetation plots will be utilized to evaluate the vegetation performance for 2% of the open areas planted acreage. Permanent vegetation monitoring plot assessments will follow CVS Level 2 protocols. Mobile vegetation monitoring plot assessments will document number of planted stems and species using a circular or 100 m2 square/rectangular plot. Planted shaded areas will be visually assessed with permanent vegetation photo points along UT5 and UT6.

6. Locations of exotic and nuisance vegetation will be mapped.

7. Locations of vegetation damage, boundary encroachments, etc. will be mapped.

APPENDIX 2. Morphological Summary Data and Plots

Table 6a. Baseline Stream Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT1 Reach 2, UT2 Reach 2, UT3 Reach 2, UT4

		Pre-Restoration Condition								Design								As-Built/Baseline							
Parameter	**Gage**	**UT1 Reach 2**		**UT2 Reach 2**		**UT3 Reach 2**		**UT4**		**UT1 Reach 2**		**UT2 Reach 2**		**UT3 Reach 2**		**UT4**		**UT1 Reach 2**		**UT2 Reach 2**		**UT3 Reach 2**		**UT4**	
		Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Dimension and Substrate - Riffle																									
Bankfull Width (ft)	N/A	5.3		3.1		4.5		N/A[1]		5.5		5.5		5.9		6.1		4.7		3.2		6.0		6.7	
Floodprone Width (ft)		15.7		21.6		7.2		N/A[1]		8	15	8	12	8	13	9	13	10		10		13		11	
Bankfull Mean Depth (ft)		0.8		0.5		0.5		N/A[1]		0.4		0.4		0.4		0.4		0.3		0.2		0.3		0.3	
Bankfull Max Depth (ft)		1.0		1.3		1.0		N/A[1]		0.5		0.5		0.6		0.6		0.4		0.3		0.6		0.6	
Bankfull Cross-sectional Area (ft^2)		4.3		1.6		2.3		N/A[1]		2.0		2.0		2.3		2.4		1.2		0.6		1.9		2.3	
Width/Depth Ratio		6.4		6.0		9.1		N/A[1]		15.0		15.0		15.0		15.0		18.4		16.9		18.4		19.7	
Entrenchment Ratio		3.0		7.0		1.6		N/A[1]		1.4	2.2	1.4	2.2	1.4	2.2	1.4	2.2	2.1		3.1		2.1		1.6	
Bank Height Ratio		1.0		1.0		2.7		N/A[1]		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
D_{50} (mm)		100		6		75		N/A[1]		---		---		---		---		64.0		67.4		61.8		71.7	
Profile																									
Riffle Length (ft)	N/A																								
Riffle Slope (ft/ft)										0.096	0.252	0.063	0.152	0.043	0.176	0.057	0.171	0.080	0.241	0.078	0.266	0.015	0.339	0.037	0.292
Pool Length (ft)																									
Pool Max Depth (ft)		1.4		---		1.2		N/A[1]		0.8	1.8	0.7	1.3	0.8	1.4	0.8	1.4	0.4	1.8	0.7	1.7	0.5	2.1	0.7	2.0
Pool Spacing (ft)		9	28	---		8	16	N/A[1]		8	17	6	14	6	15	9	18	7	20	7	22	5	36	14	34
Pool Volume (ft^3)																									
Pattern																									
Channel Beltwidth (ft)	N/A	N/A[2]		N/A[2]		N/A[2]		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Radius of Curvature (ft)		N/A[2]		N/A[2]		N/A[2]		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Rc/Bankfull Width (ft/ft)		N/A[2]		N/A[2]		N/A[2]		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Meander Length (ft)		N/A[2]		N/A[2]		N/A[2]		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Meander Width Ratio		N/A[2]		N/A[2]		N/A[2]		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Substrate, Bed and Transport Parameters																									
Ri%/Ru%/P%/G%/S%	N/A																								
SC%/Sa%/G%/C%/B%/Be%																									
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$		0.5/15-20/100/ 300-400/>1400		0.25/0.7/5.5/ 15/250		20-25/45/75/ 150/270		N/A[1]										0.3/2/12.8/90/ 180/512		0.4/4/25.4/99.5/ 202.4/>2048		0.3/0.73/7.1/ 155.5/315.2/512		0.3/1.34/20.7/ 154.8/272.5/512	
Reach Shear Stress (Competency) lb/ft^2		2.6		3.3		4.1		2.8		3.8		3.3		4.1		2.8		2.0		1.8		3.7		2.3	
Max part size (mm) mobilized at bankfull										311		366		428		322		99		90		181		112	
Stream Power (Capacity) W/m^2																									
Additional Reach Parameters																									
Drainage Area (SM)	N/A	0.11		0.05		0.06		0.05		0.11		0.05		0.06		0.05		0.11		0.05		0.06		0.05	
Watershed Impervious Cover Estimate (%)		<1%								<1%								<1%							
Rosgen Classification		A4a+		A4a+		A4a+		N/A[1]		A4a+/B4a		A4a+/B4a		A4a+/B4a		A4a+/B4a		A4a+/B4a		A4a+/B4a		A4a+/B4a		A4a+/B4a	
Bankfull Velocity (fps)		8.1		7.4		8.3		N/A[1]		6.4		7.2		8.1		6.7		5.3		4.8		7.6		5.9	
Bankfull Discharge (cfs)		35		12		19		N/A[1]		13		14		19		16		6		3		21		14	
Q-NFF regression (2-yr)		---		---		---		---																	
Q-USGS extrapolation (1.2-yr)		16		9		10		9		---		---		---		---									
Max Q-Mannings		44		12		19		---		---		12		19		N/A[1]									
Valley Slope (ft/ft)		0.1262		0.1520		0.1757		0.1102		0.1164		0.1659		0.176		0.1102		---		---		---		---	
Channel Thalweg Length (ft)		255		296		1,387[1]		910[1]		278		304		1,019		930		278		304		1,019		930	
Sinuosity		1.05		1.01		1.03		N/A[1]		1.03		1.07		1.05		1.02		1.03		1.07		1.05		1.02	
Bankfull/Channel Slope (ft/ft)		0.1200		0.1500		0.1700		N/A[1]		0.1130		0.1550		0.1650		0.1080		0.1279		0.1592		0.1643		0.1093	

1. Some or all of UT3 Reach 2 and UT4 had been previous buried in rock-lined channel or pipes so cross-section data could not be collected. Reported lengths are estimates based upon land owner communiction, remote sensing, and field verification.
2. Pattern data is not applicable for A-type and B-type channels
SC: Silt/Clay <0.062 mm diameter particles
(---): Data was not provided
N/A: Not Applicable

Table 6b. Baseline Stream Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT8, Shake Rag Branch

		Pre-Restoration Condition								Design								As-Built/Baseline							
Parameter	**Gage**	**UT8**		**Shake Rag Branch Reach 3**		**Shake Rag Branch Reach 4**		**Shake Rag Branch Reach 5**		**UT8**		**Shake Rag Branch Reach 3**		**Shake Rag Branch Reach 4**		**Shake Rag Branch Reach 5**		**UT8**		**Shake Rag Branch Reach 3**		**Shake Rag Branch Reach 4**		**Shake Rag Branch Reach 5**	
		Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Dimension and Substrate - Riffle																									
Bankfull Width (ft)	N/A	N/A[1]		3.3		5.1		6.7		5.2		5.8		7.2		8.8		5.3		5.2	5.5	7.6		8.1	
Floodprone Width (ft)		N/A[1]		25		15		9		7	11	8	13	10	16	12	19	36		10		19		46	
Bankfull Mean Depth (ft)		N/A[1]		0.5		0.6		0.7		0.4		0.4		0.5		0.6		0.3		0.3		0.5		0.4	
Bankfull Max Depth (ft)		N/A[1]		0.9		0.9		1.5		0.5		0.6		1.4		0.8		0.5		0.6		0.9		0.8	
Bankfull Cross-sectional Area (ft^2)		N/A[1]		1.7		2.9		5.0		1.9		2.4		3.6		5.1		1.4		1.6	1.7	4.0		3.5	
Width/Depth Ratio		N/A[1]		6.2		9.0		9.0		15.0		14.0		15.0		15.0		19.9		16.6	17.5	14.6		18.4	
Entrenchment Ratio		N/A[1]		7.5		2.9		1.3		1.4	2.2	1.4	2.2	1.4	2.2	1.4	2.2	6.8		1.8	1.9	2.5		5.8	
Bank Height Ratio		N/A[1]		1.1		1.0		3.1		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
D_{50} (mm)		N/A[1]		N/A[1]		---		10-20		---		---		---		---		24.7		75.9	84.1	72.7		101.2	
Profile																									
Riffle Length (ft)	N/A																								
Riffle Slope (ft/ft)										0.045	0.161	0.064	0.166	0.065	0.120	0.040	0.123	0.012	0.151	0.052	0.421	0.038	0.094	0.040	0.143
Pool Length (ft)																									
Pool Max Depth (ft)		N/A[1]		---		---		1.8		0.7	1.3	0.8	1.4	1.0	1.8	1.2	2.0	0.7	1.4	0.4	2.2	0.8	1.9	0.8	2.4
Pool Spacing (ft)		N/A[1]		---		---		7	18	8	18	9	17	11	25	11	31	5	18	8	51	9	86	7	47
Pool Volume (ft^3)																									
Pattern																									
Channel Beltwidth (ft)	N/A	N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Radius of Curvature (ft)		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Rc/Bankfull Width (ft/ft)		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Meander Length (ft)		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Meander Width Ratio		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Substrate, Bed and Transport Parameters																									
Ri%/Ru%/P%/G%/S%	N/A																								
SC%/Sa%/G%/C%/B%/Be%																									
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$		N/A[1]		N/A[1]		---		1-2/8-9/10-20/ 90-100/180										0.1/0.3/5.7/ 35.5/78.3/180		0.3/2/14.6/ 110.1/207.2/512		0.3/1.3/14.6/ 105.8/237.7/512		0.4/1.6/21.1/ 157.9/243.4/512	
Reach Shear Stress (Competency) lb/ft^2		---		3.2		---		2.4		---		3.2		---		2.4		1.2		2.5	2.6	2.4		1.8	
Max part size (mm) mobilized at bankfull										---		357		---		288		60		122	126	120		86	
Stream Power (Capacity) W/m^2																									
Additional Reach Parameters																									
Drainage Area (SM)	N/A	0.03		0.06		0.12		0.24		0.03		0.06		0.12		0.25		0.03		0.06		0.12		0.25	
Watershed Impervious Cover Estimate (%)		<1%								<1%								<1%							
Rosgen Classification		N/A[1]		A4a+		A4/B4a		A4		A4/B4a		A4a+/B4a		A4/B4a		A4/B4a		A4/B4a		A4a+/B4a		A4/B4a		A4/B4a	
Bankfull Velocity (fps)		N/A[1]		9.6		8.1		6.8		5.5		7.1		6.8		6.6		4.2		6.1	6.2	6.6		5.4	
Bankfull Discharge (cfs)		N/A[1]		16		23		34		10		17		24		34		6		10	11	26		19	
Q-NFF regression (2-yr)		---		---		---		---																	
Q-USGS extrapolation (1.2-yr)		6		10		17		29		---		---		---		---									
Max Q-Mannings		---		16		24		34		N/A[1]		16		24		34									
Valley Slope (ft/ft)		0.0901		0.1317		0.0976		0.0685		0.0901		0.1523		0.0832		0.0685		---		---		---		---	
Channel Thalweg Length (ft)		210[1]		1,451[1]		385		1,216		206		1,393		385		1,134		206		1,345		385		1,134	
Sinuosity		N/A[1]		1.03		1.07		1.04		1.06		1.03		1.08		1.01		1.06		1.03		1.08		1.01	
Bankfull/Channel Slope (ft/ft)		N/A[1]		0.1275		0.0913		0.0659		0.0850		0.1360		0.0770		0.0660		0.0761		0.1341		0.0775		0.0660	

1. Some or all of SRB Reach 3 and UT8 had been previous buried in rock-lined channel or pipes so cross-section data could not be collected. Reported lengths are estimates based upon land owner communiction, remote sensing, and field verification.
2. Pattern data is not applicable for A-type and B-type channels
SC: Silt/Clay <0.062 mm diameter particles
(---): Data was not provided
N/A: Not Applicable

Table 7. Reference Reach Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Parameter	Gage	Reference Reach Data											
		Ironwood Tributary		UT to South Fork Fishing Creek		UT to Austin Branch (upstream)		UT to Austin Branch (downstream)		UT to Gap Branch		UT to Hampton Creek	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle													
Bankfull Width (ft)	N/A	5.0		4.1		6.7		6.2		6.2		6.8	
Floodprone Width (ft)		10		7		18		27		21		12	
Bankfull Mean Depth		0.6		0.4		0.5		0.7		0.6		0.7	
Bankfull Max Depth		0.8		0.7		0.8		1.2		1.0		1.0	
Bankfull Cross-sectional Area (ft^2)		2.7		1.8		3.6		4.4		3.8		4.6	
Width/Depth Ratio		9.1		9.3		12.8		8.8		10.1		10.0	
Entrenchment Ratio		2.1		1.7		2.6		4.3		3.4		1.7	
Bank Height Ratio		1.3		1.0		1.0		1.0		1.0		1.0	
D50 (mm)		0.9		1.2		59		59		19		Coarse gravel	
Profile													
Riffle Length (ft)	N/A	---		---		---		---		---		---	
Riffle Slope (ft/ft)		---		0.0240	0.2000	0.0810	0.2900	0.0250	0.0730	0.0110	0.1400	0.0500	0.1000
Pool Length (ft)		---		---		---		---		---		---	
Pool Max Depth (ft)		---		---		1.7		1.7		1.6		1.3	
Pool Spacing (ft)		---		6	32	10	17	14	31	18	27	11	19
Pool Volume (ft^3)													
Pattern													
Channel Beltwidth (ft)	N/A	---		---		---		---		---		---	
Radius of Curvature (ft)		---		---		---		---		---		---	
Rc/Bankfull Width (ft/ft)		---		---		---		---		---		---	
Meander Length (ft)		---		---		---		---		---		---	
Meander Width Ratio		---		---		---		---		---		---	
Substrate, Bed and Transport Parameters													
Ri%/Ru%/P%/G%/S%	N/A												
SC%/Sa%/G%/C%/B%/Be%													
d16/d35/d50/d84/d95/d100		0.26/0.5/0.91/19/ 97/128		0.1/0.3/1.2/11/ 24/64		11/42/59/130/ 170/256		11/42/59/130/ 170/256		0.4/8/19/102.3/ 257/>2048		---	
Reach Shear Stress (Competency) lb/ft^2													
Max part size (mm) mobilized at bankfull													
Stream Power (Capacity) W/m^2													
Additional Reach Parameters													
Drainage Area (SM)	N/A	0.03		0.02		0.12		0.12		0.04		0.25	
Watershed Impervious Cover Estimate (%)		---		---		---		---		---		---	
Rosgen Classification		A5a+		B5a		A4/B4a		A4/B4a		A4/B4a		A4/B4a	
Bankfull Velocity (fps)		4.9		4.1		7.3		6.2		5.0		6.6	
Bankfull Discharge (cfs)		13		8		26		27		19		31	
Q-NFF regression (2-yr)													
Q-USGS extrapolation (1.2-yr)													
Q-Mannings													
Valley Slope (ft/ft)		0.1418		0.1025		0.1000		0.0480		---		0.0840	
Channel Thalweg Length (ft)		---		---		---		---		---		---	
Sinuosity		1.2		1.25		1.00		1.20		---		1.10	1.20
Water Surface Slope (ft/ft)		---		---		---		---		---		---	
Bankfull/Channel Slope (ft/ft)		0.1139		0.0815		0.0986		0.0400		0.0680		0.0650	

SC: Silt/Clay <0.062 mm diameter particles
(---): Data was not provided
N/A: Not Applicable

Table 8a. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)

Shake Rag Mitigation Site

DMS Project No. 100018

Monitoring Year 0 - 2020

	UT1 Reach 2 Cross-Section 1, Riffle								UT2 Reach 2 Cross-Section 2, Riffle								UT3 Reach 2 Cross-Section 3, Riffle							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation	*2709.81*								*2738.54*								*2617.65*							
Bankfull Width (ft)	4.7								3.2								6.0							
Floodprone Width (ft)	10								10								13							
Bankfull Mean Depth (ft)	0.3								0.2								0.3							
Bankfull Max Depth (ft)	0.4								0.3								0.6							
Bankfull Cross-Sectional Area (ft^2)	1.2								0.6								1.9							
Bankfull Width/Depth Ratio	18.4								16.9								18.4							
Bankfull Entrenchment Ratio	2.1								3.1								2.1							
Bankfull Bank Height Ratio	1.0								1.0								1.0							

	UT3 Reach 2 Cross-Section 4, Pool								UT4 Cross-Section 5, Riffle								UT4 Cross-Section 6, Pool							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation	*2616.07*								*2503.01*								*2499.51*							
Bankfull Width (ft)	5.4								6.7								5.9							
Floodprone Width (ft)	---								11								---							
Bankfull Mean Depth (ft)	0.7								0.3								0.7							
Bankfull Max Depth (ft)	1.1								0.6								1.0							
Bankfull Cross-Sectional Area (ft^2)	4.0								2.3								4.4							
Bankfull Width/Depth Ratio	7.3								19.7								7.9							
Bankfull Entrenchment Ratio	---								1.6								---							
Bankfull Bank Height Ratio	---								1.0								---							

	UT8 Cross-Section 7, Riffle							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation	*2520.23*							
Bankfull Width (ft)	5.3							
Floodprone Width (ft)	36							
Bankfull Mean Depth (ft)	0.3							
Bankfull Max Depth (ft)	0.5							
Bankfull Cross-Sectional Area (ft^2)	1.4							
Bankfull Width/Depth Ratio	19.9							
Bankfull Entrenchment Ratio	6.8							
Bankfull Bank Height Ratio	1.0							

Table 8b. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)

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	Shake Rag Branch Reach 3 Cross-Section 8, Riffle								Shake Rag Branch Reach 3 Cross-Section 9, Riffle								Shake Rag Branch Reach 3 Cross-Section 10, Pool							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation	*2632.06*								*2621.09*								*2620.50*							
Bankfull Width (ft)	5.2								5.5								4.0							
Floodprone Width (ft)	10								10								---							
Bankfull Mean Depth (ft)	0.3								0.3								0.8							
Bankfull Max Depth (ft)	0.6								0.6								1.1							
Bankfull Cross-Sectional Area (ft^2)	1.6								1.7								3.0							
Bankfull Width/Depth Ratio	16.6								17.5								5.3							
Bankfull Entrenchment Ratio	1.9								1.8								---							
Bankfull Bank Height Ratio	1.0								1.0								---							
	Shake Rag Branch Reach 4 Cross-Section 11, Riffle								**Shake Rag Branch Reach 5 Cross-Section 12, Riffle**								**Shake Rag Branch Reach 5 Cross-Section 13, Pool**							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation	*2530.35*								*2500.82*								*2500.20*							
Bankfull Width (ft)	7.6								8.1								7.2							
Floodprone Width (ft)	19								46								---							
Bankfull Mean Depth (ft)	0.5								0.4								1.1							
Bankfull Max Depth (ft)	0.9								0.8								1.9							
Bankfull Cross-Sectional Area (ft^2)	4.0								3.5								8.1							
Bankfull Width/Depth Ratio	14.6								18.4								6.4							
Bankfull Entrenchment Ratio	2.5								5.8								---							
Bankfull Bank Height Ratio	1.0								1.0								---							

Longitudinal Profile Plots

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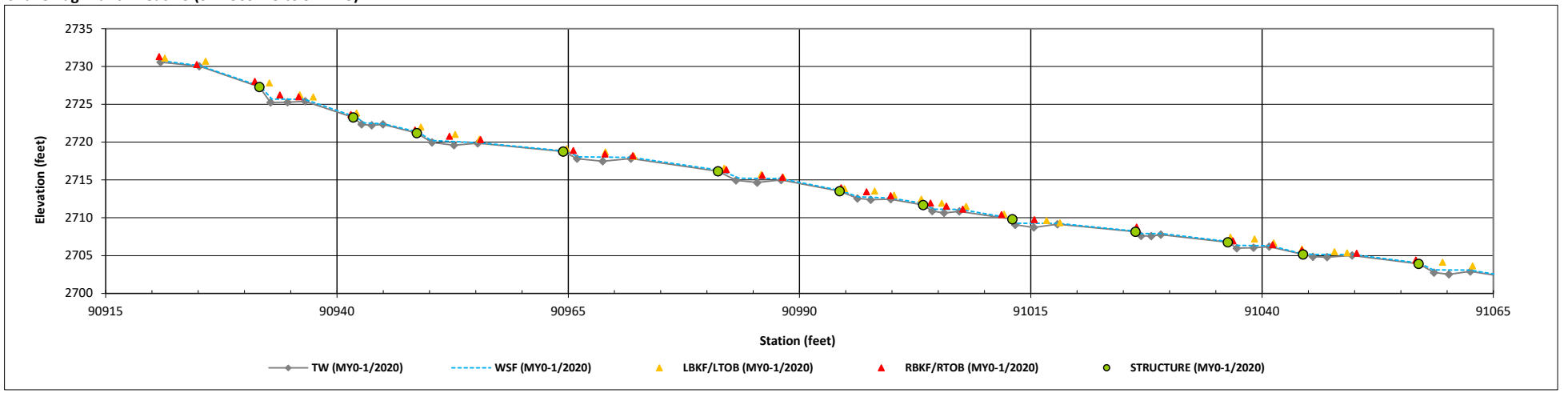
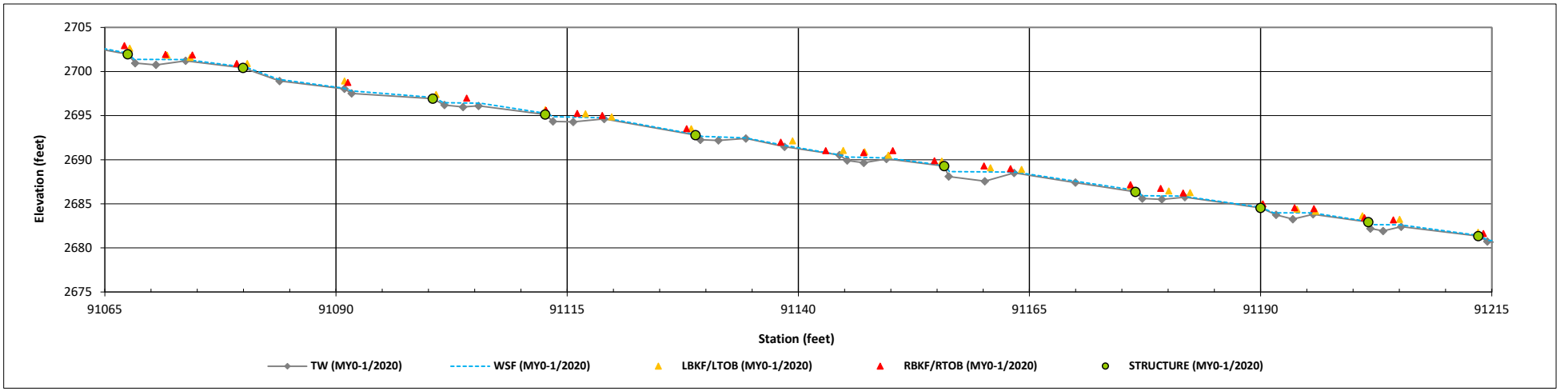
Shake Rag Branch Reach 3 (STA 909+15 to 912+15)





Longitudinal Profile Plots

Shake Rag Mitigation Site
DMS Project No. 100018
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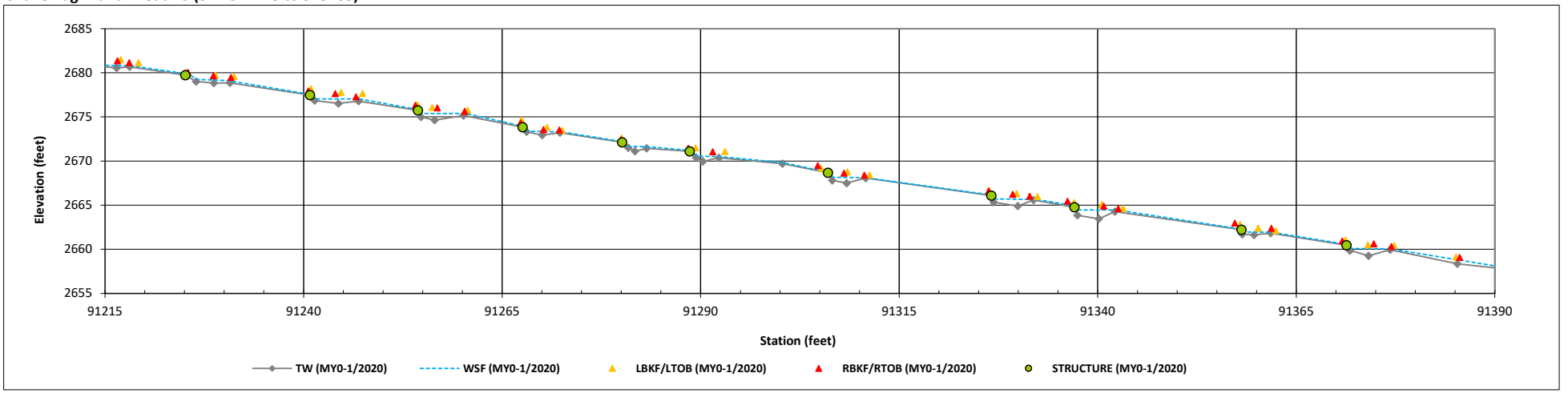
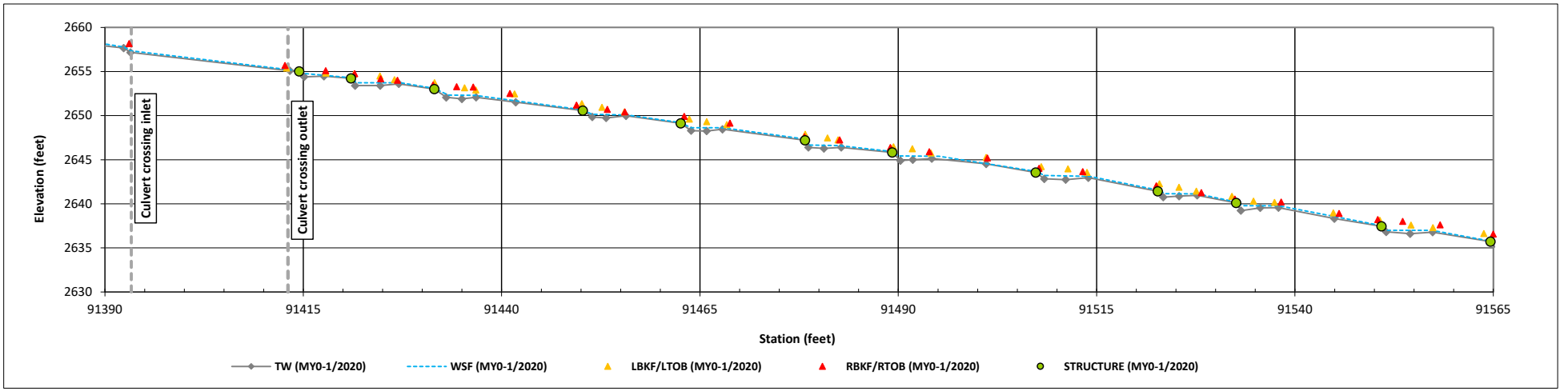
Shake Rag Branch Reach 3 (STA 912+15 to 915+65)





Longitudinal Profile Plots

Shake Rag Mitigation Site
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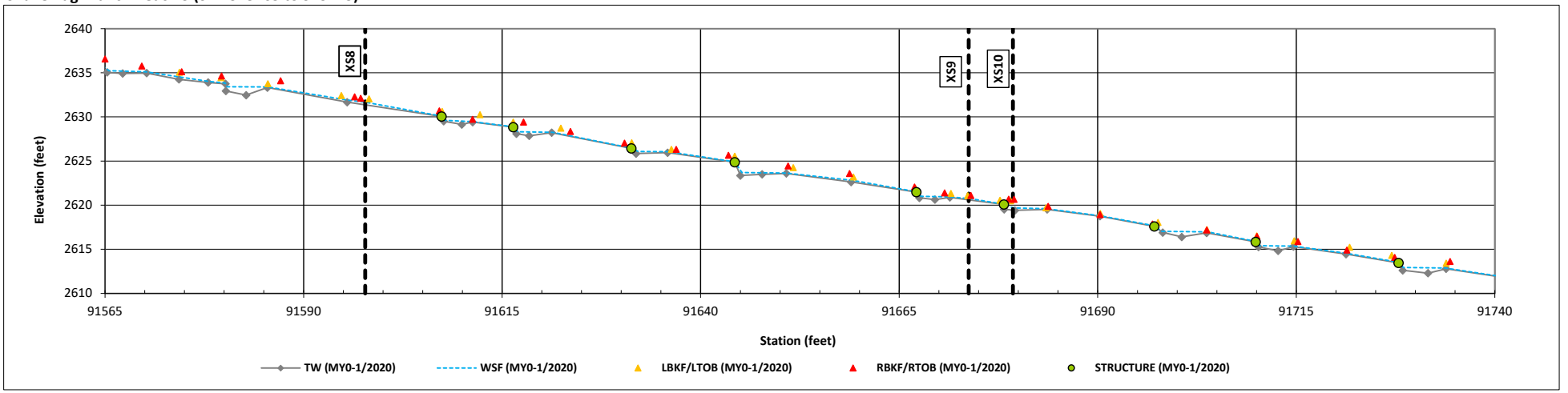
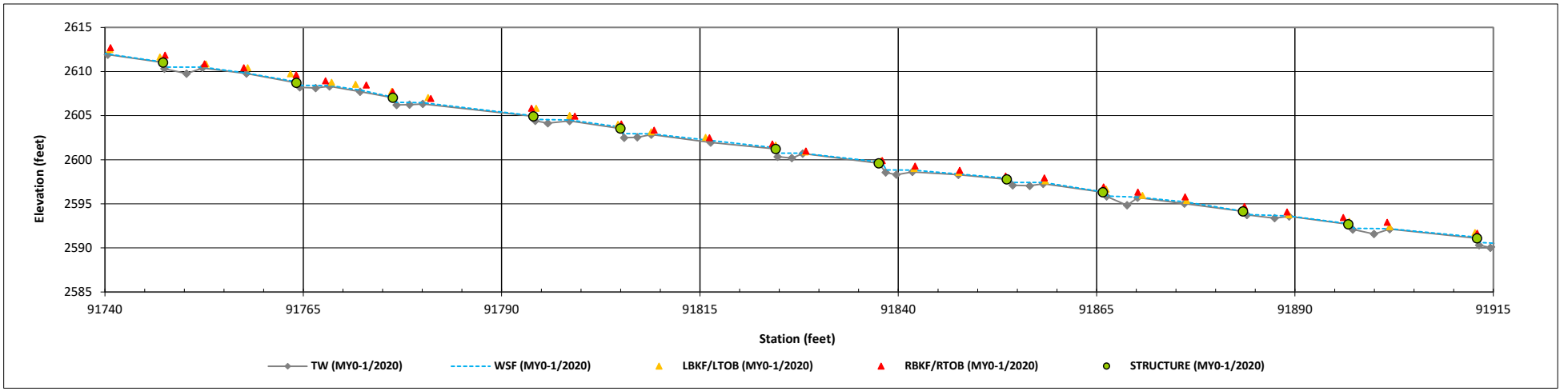
Shake Rag Branch Reach 3 (STA 915+65 to 919+15)





Longitudinal Profile Plots

Shake Rag Mitigation Site
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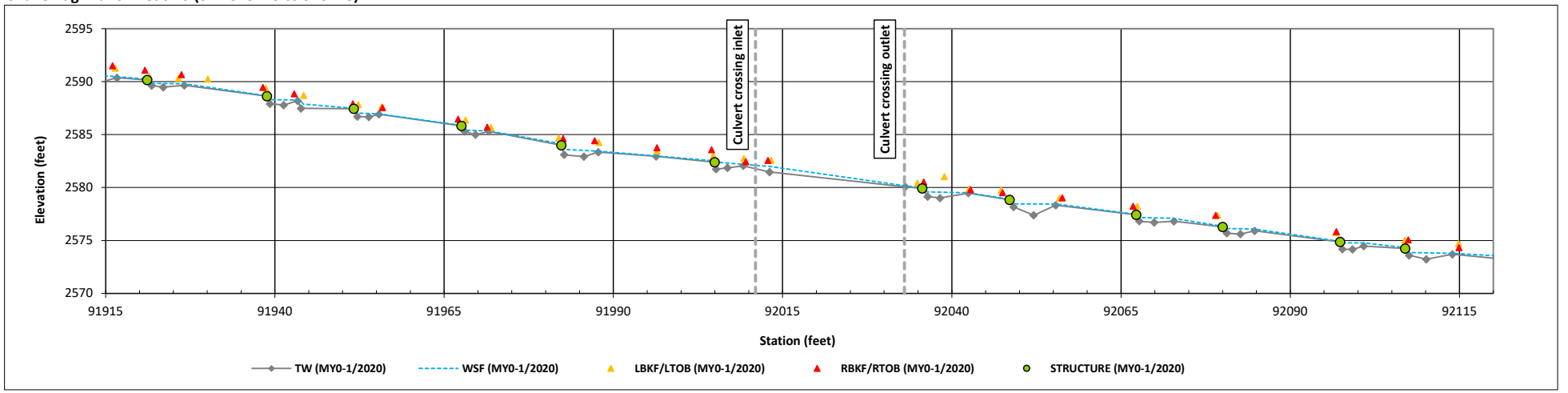
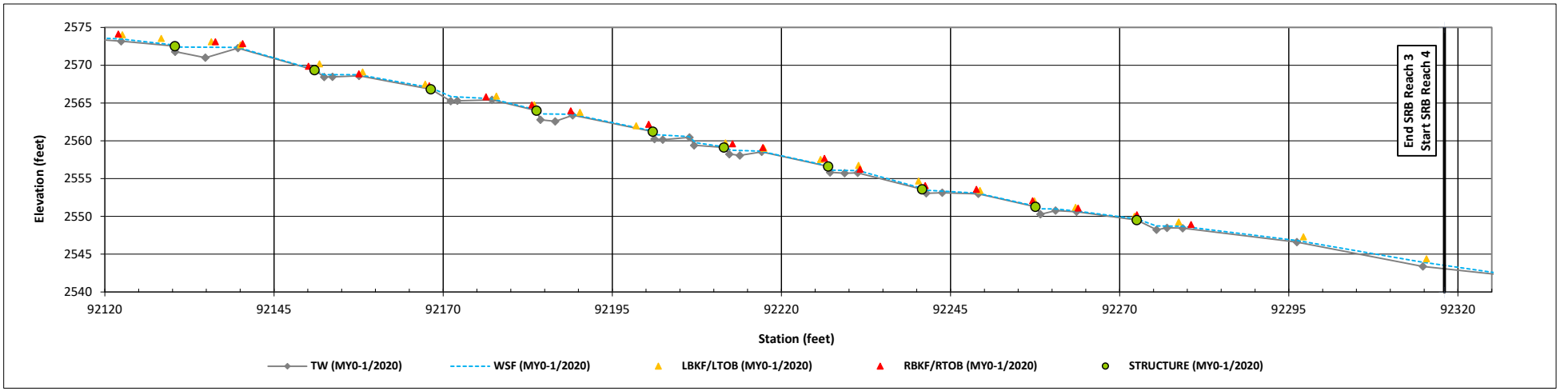
Shake Rag Branch Reach 3 (STA 919+15 to 923+18)





Longitudinal Profile Plots

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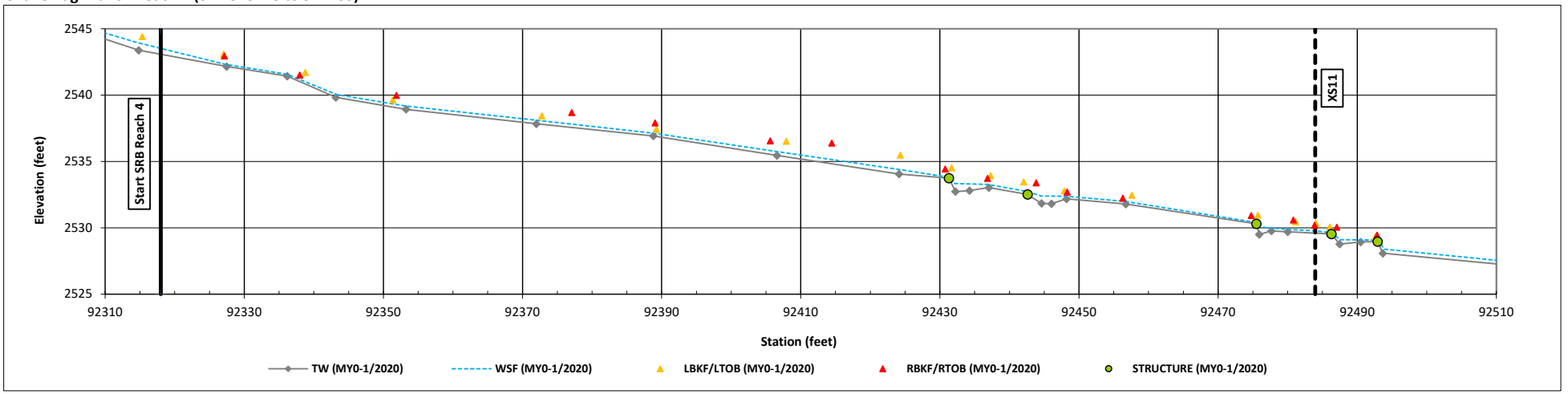
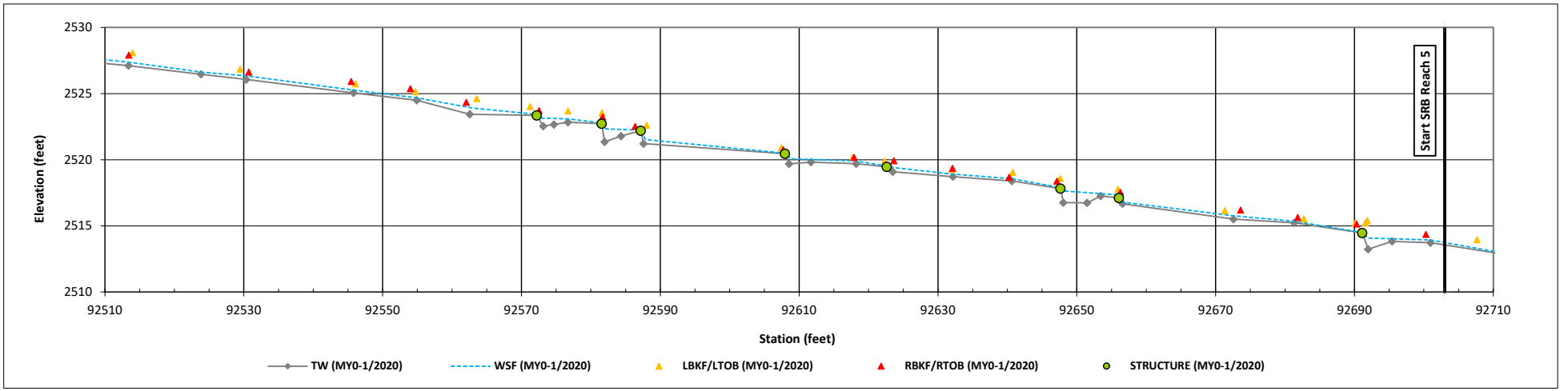
Shake Rag Branch Reach 4 (STA 923+18 to 927+03)





Longitudinal Profile Plots

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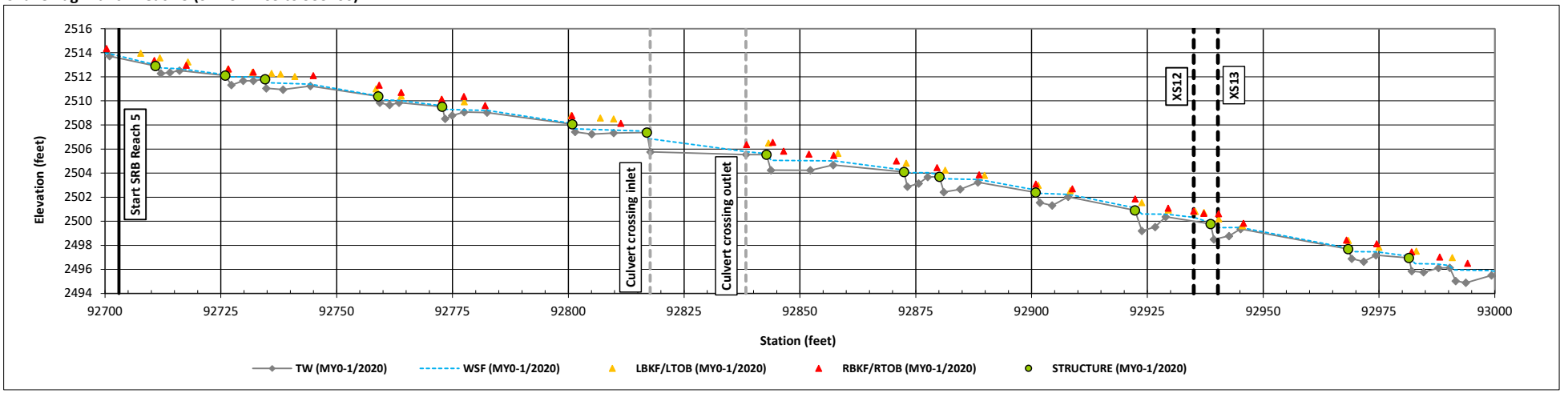
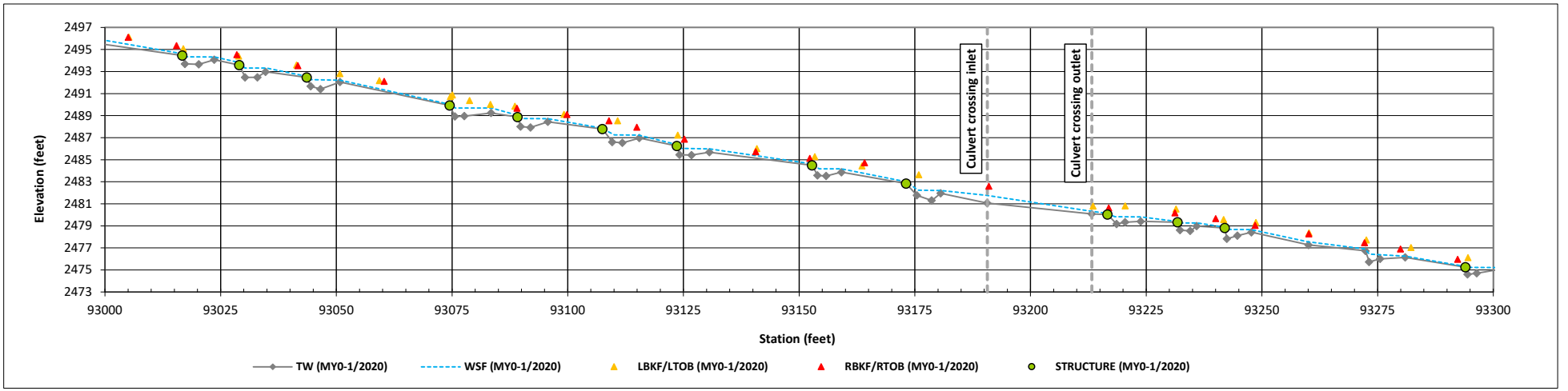
Shake Rag Branch Reach 5 (STA 927+03 to 933+00)





Longitudinal Profile Plots

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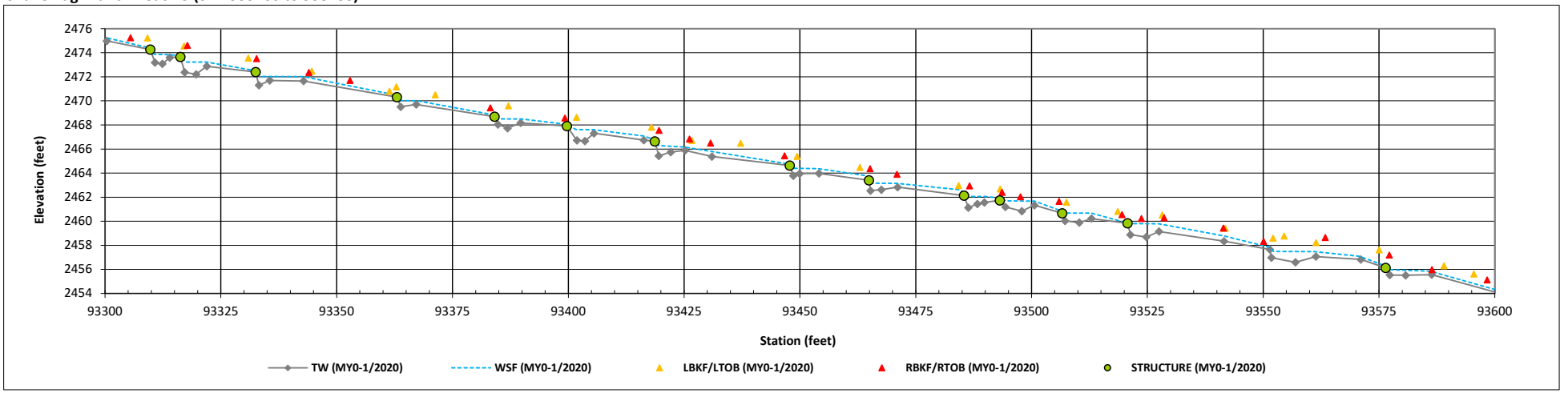
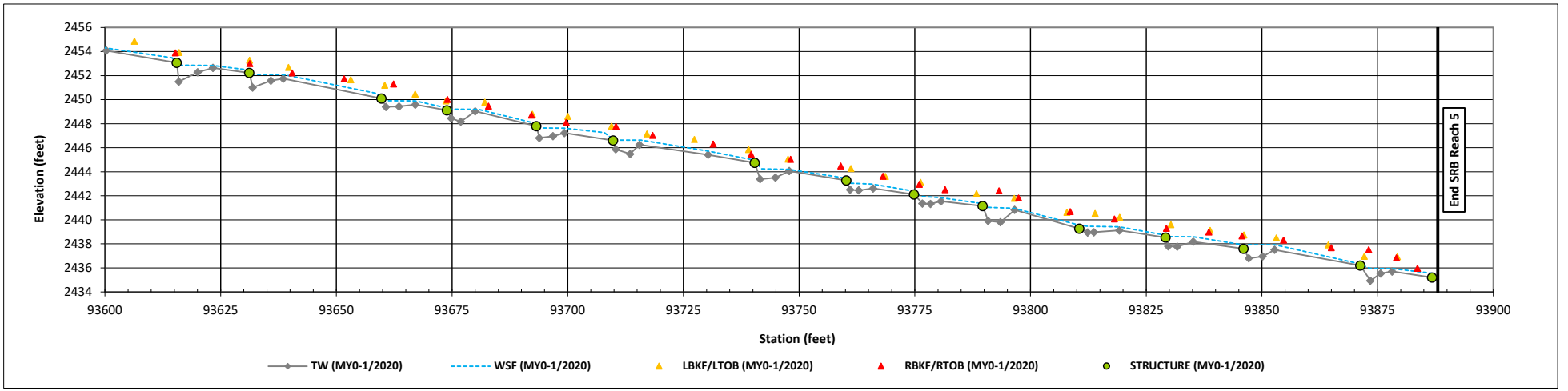
Shake Rag Branch Reach 5 (STA 933+00 to 938+88)





Longitudinal Profile Plots

Shake Rag Mitigation Site
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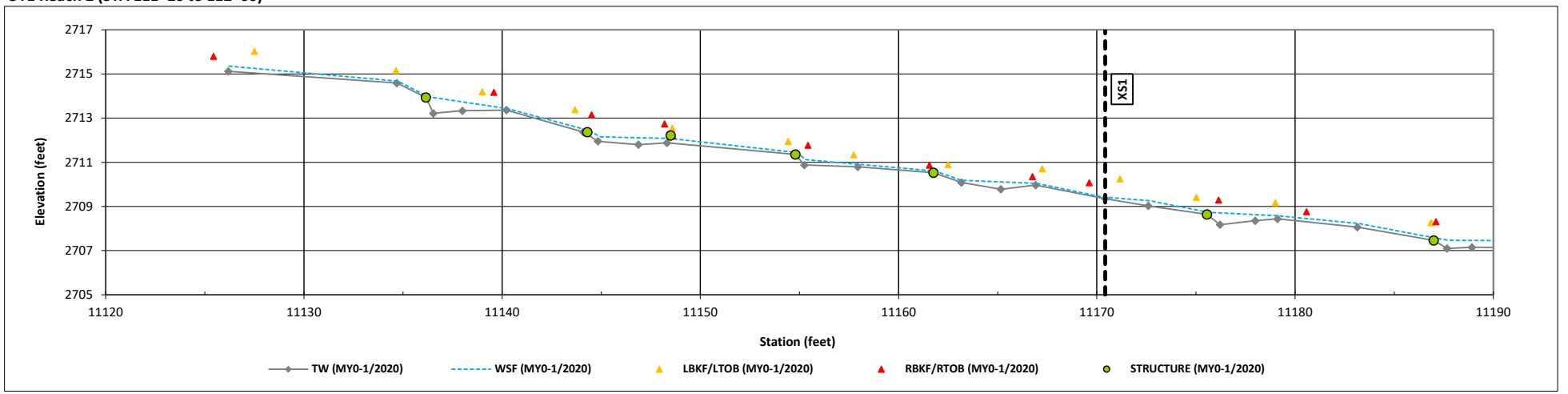
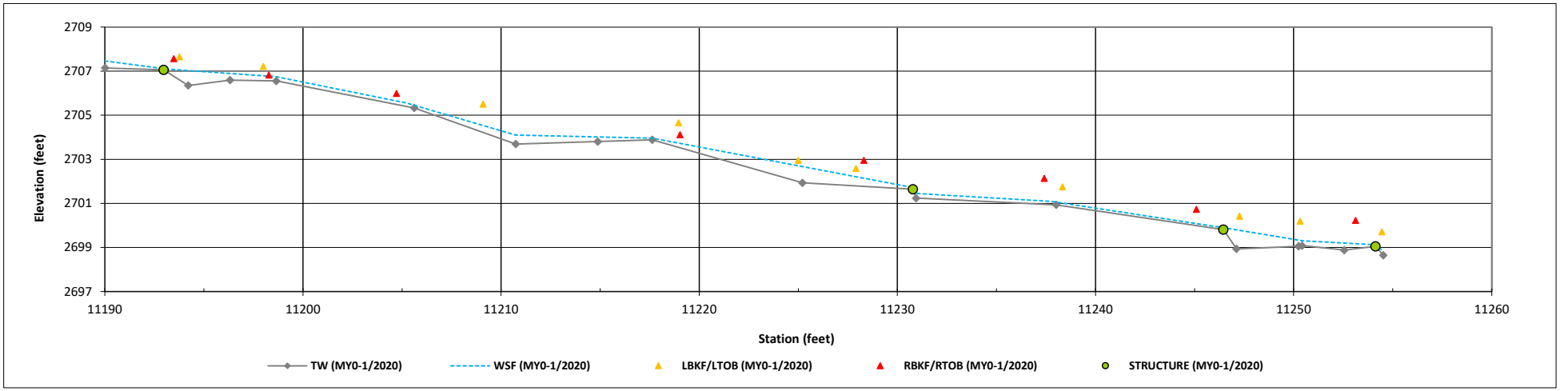
UT1 Reach 2 (STA 111+20 to 112+60)





Longitudinal Profile Plots

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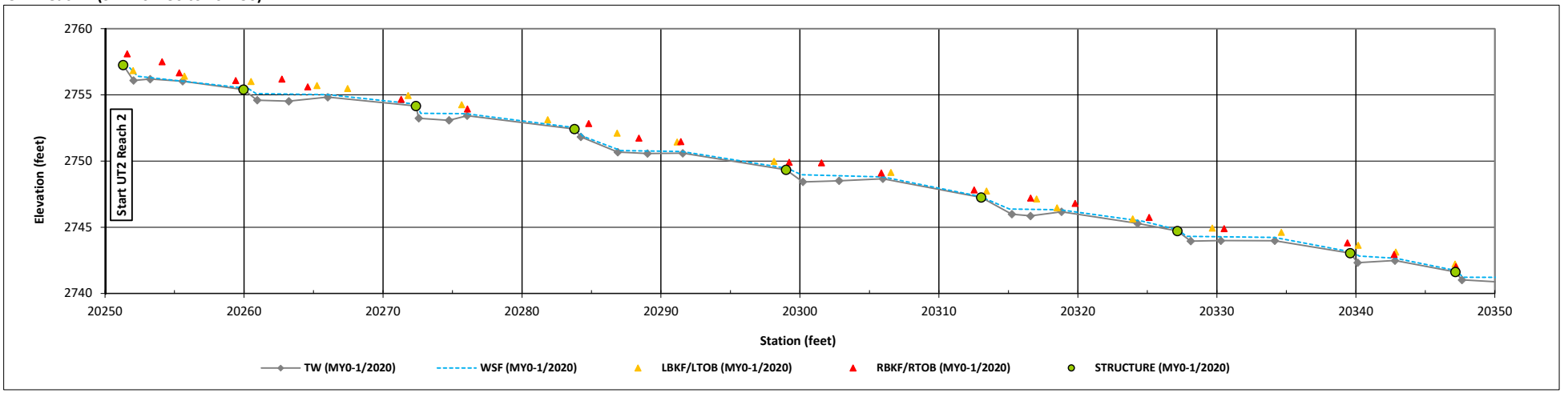
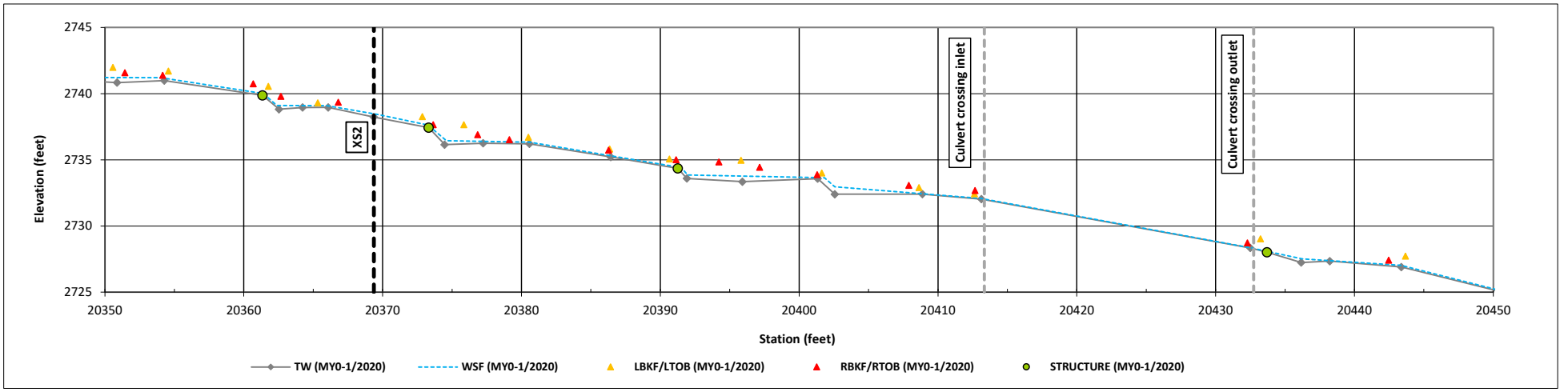
UT2 Reach 2 (STA 202+50 to 204+50)





Longitudinal Profile Plots

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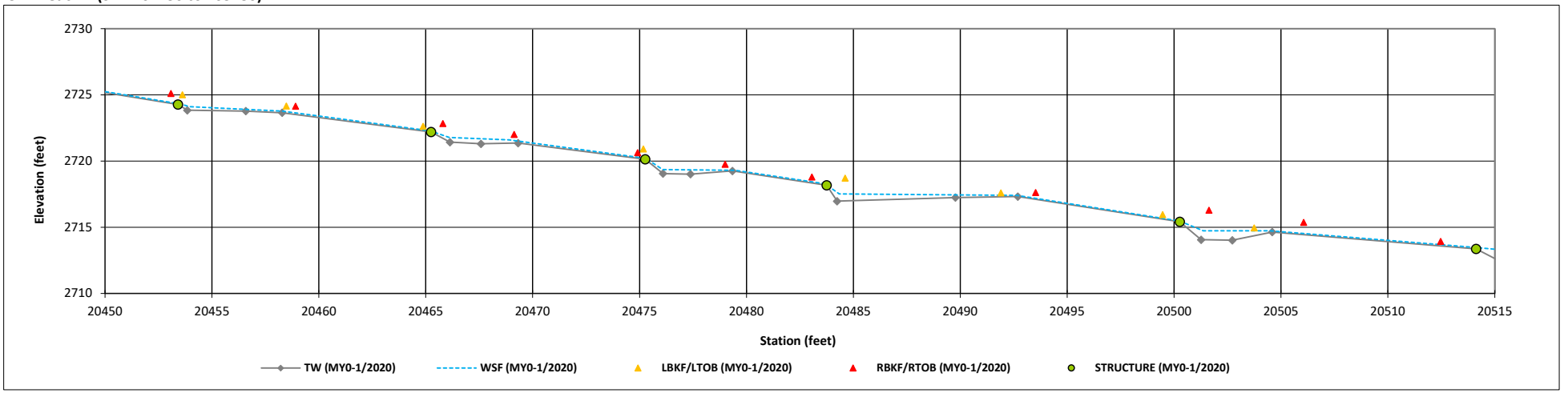
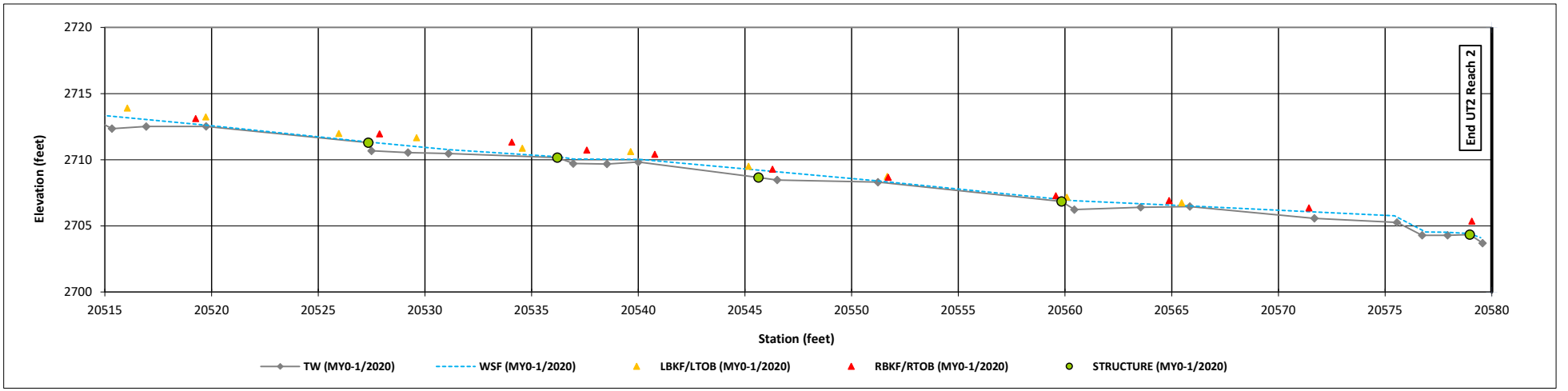
UT2 Reach 2 (STA 204+50 to 205+80)





Longitudinal Profile Plots

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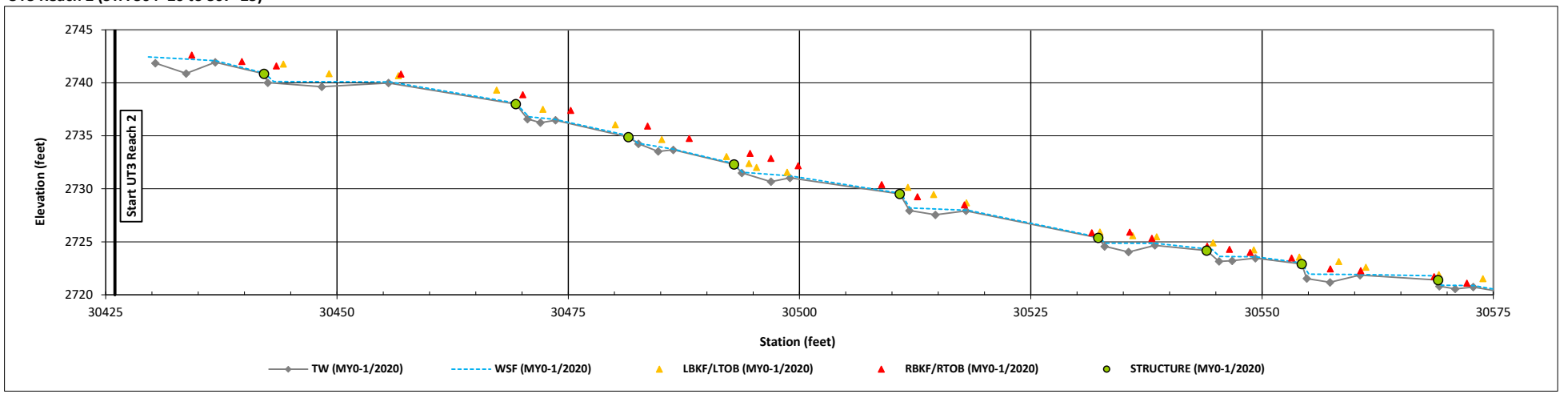
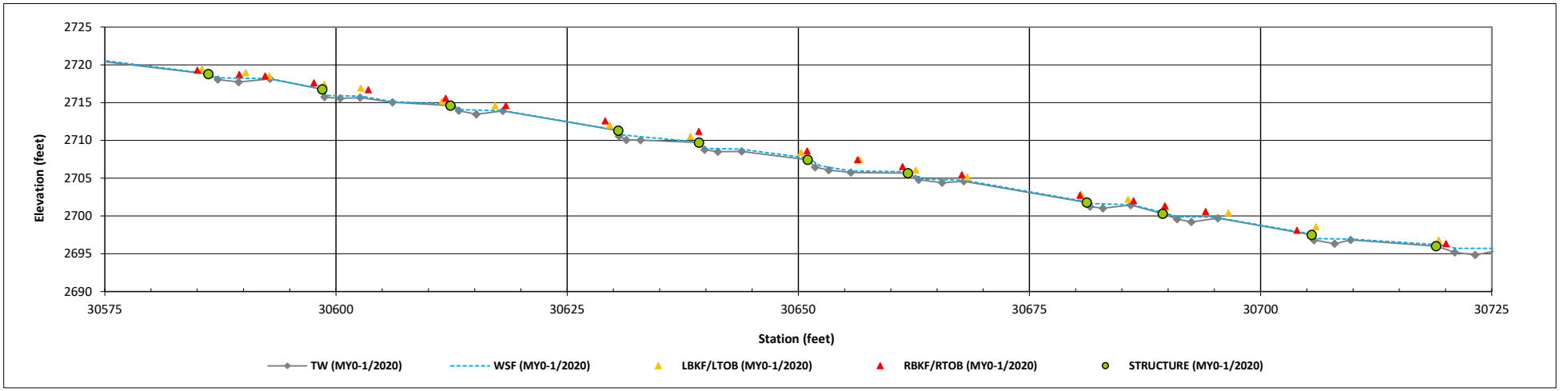
UT3 Reach 2 (STA 304+26 to 307+25)





Longitudinal Profile Plots

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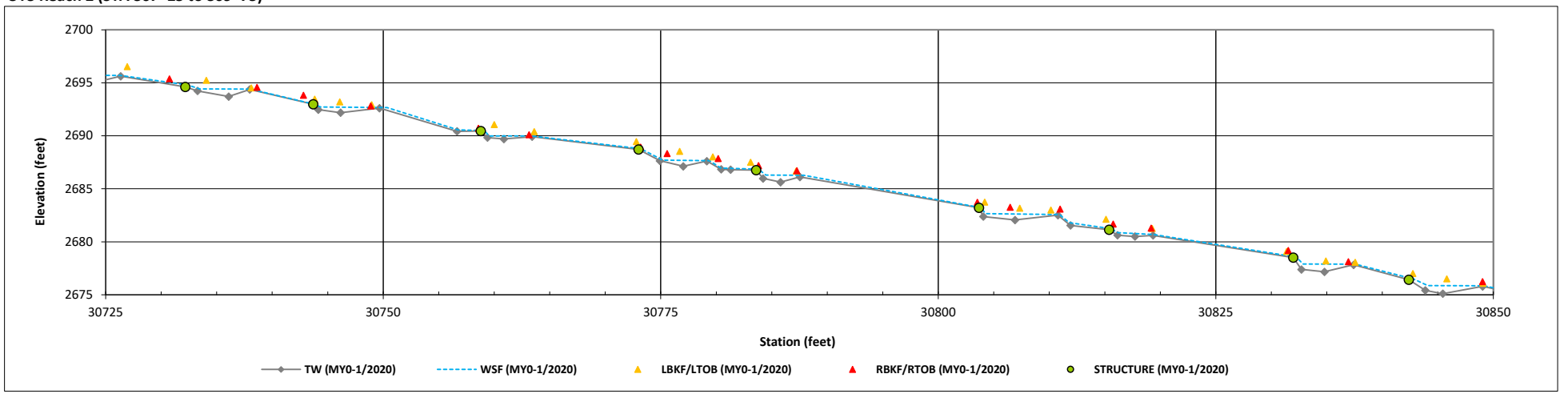
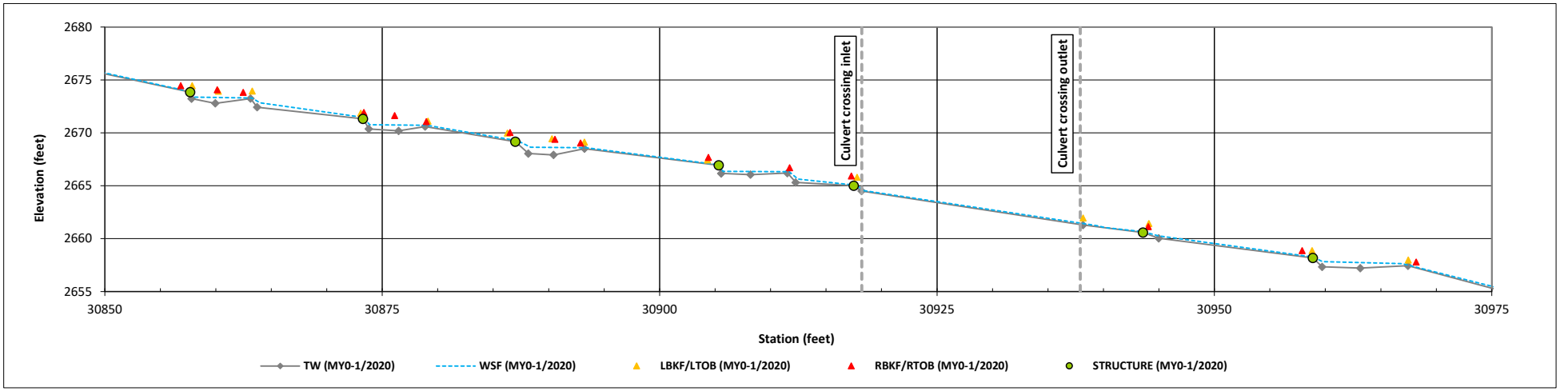
UT3 Reach 2 (STA 307+25 to 309+75)





Longitudinal Profile Plots

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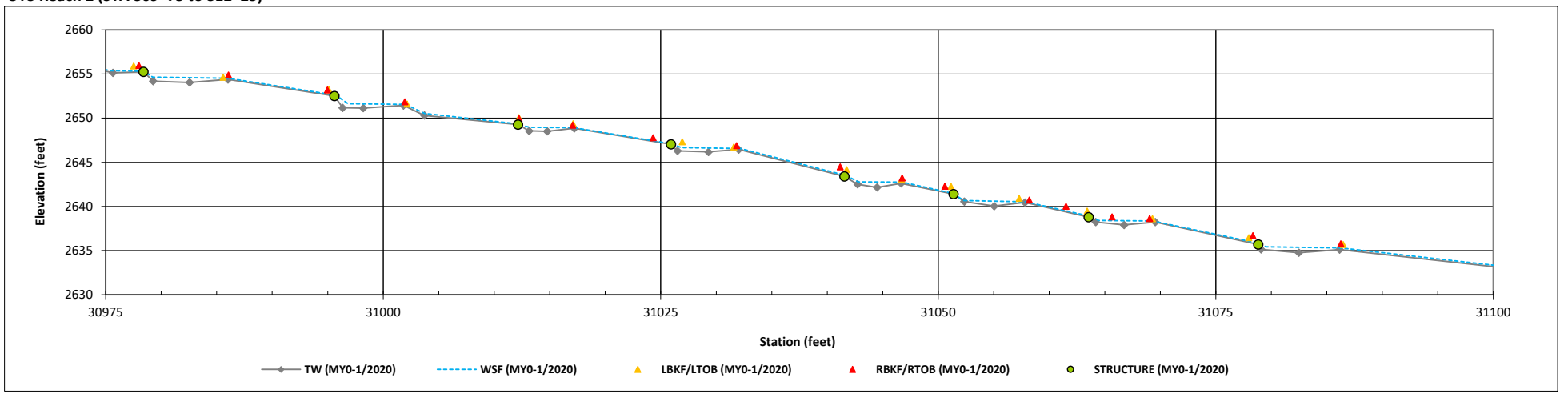
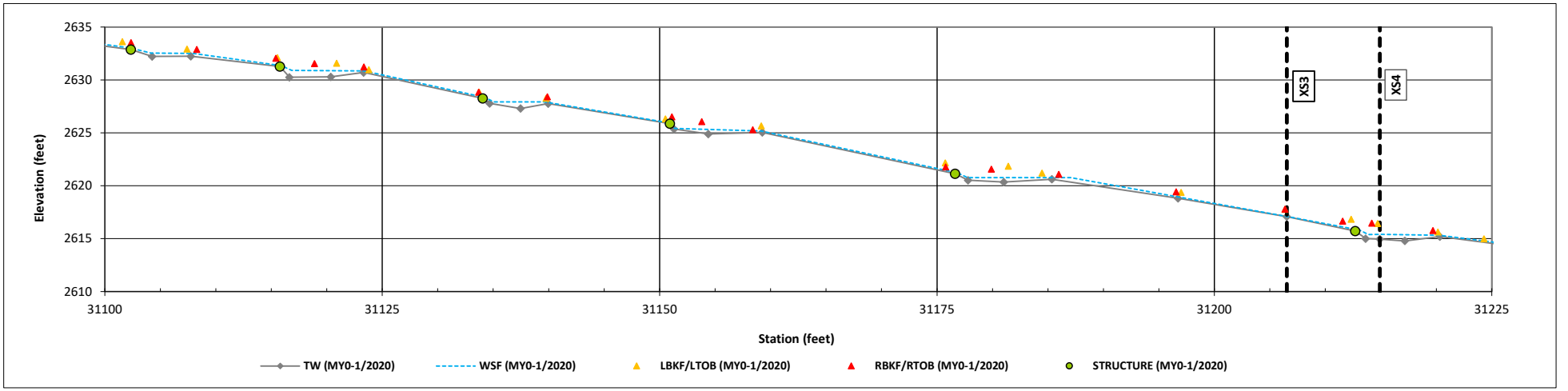
UT3 Reach 2 (STA 309+75 to 312+25)





Longitudinal Profile Plots

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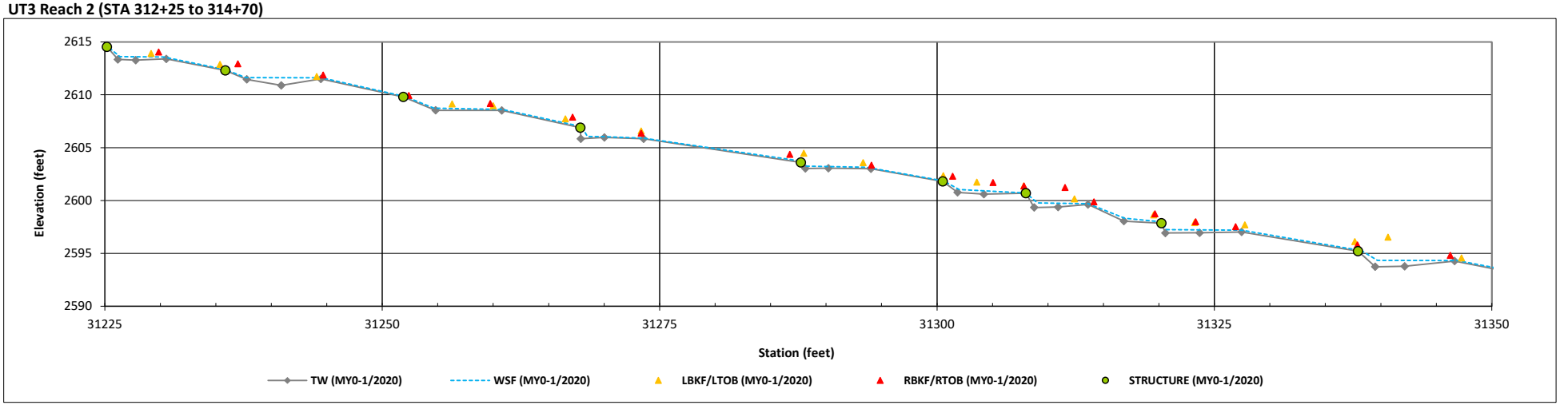
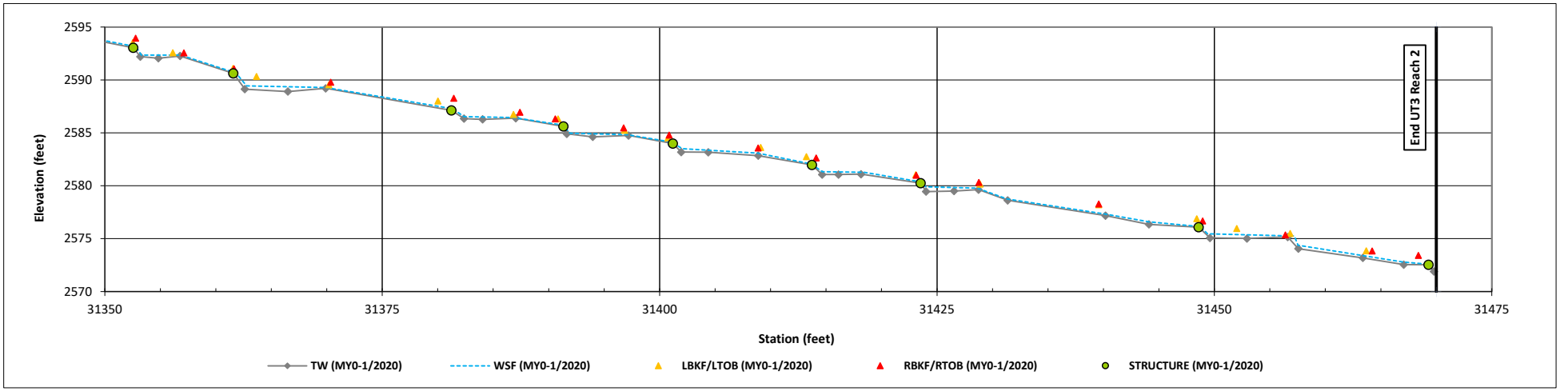
UT3 Reach 2 (STA 312+25 to 314+70)





Longitudinal Profile Plots

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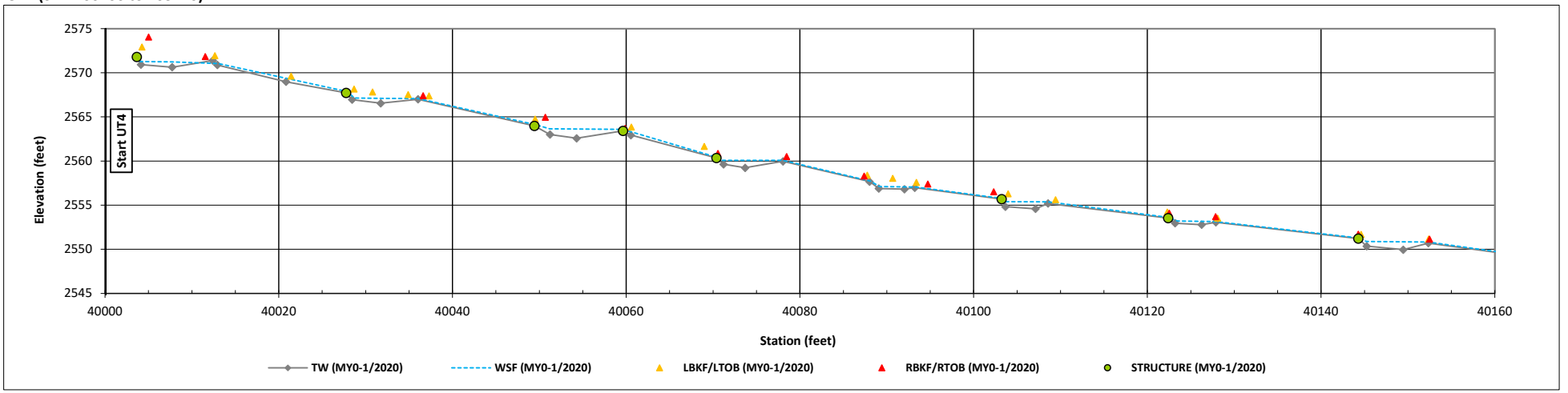
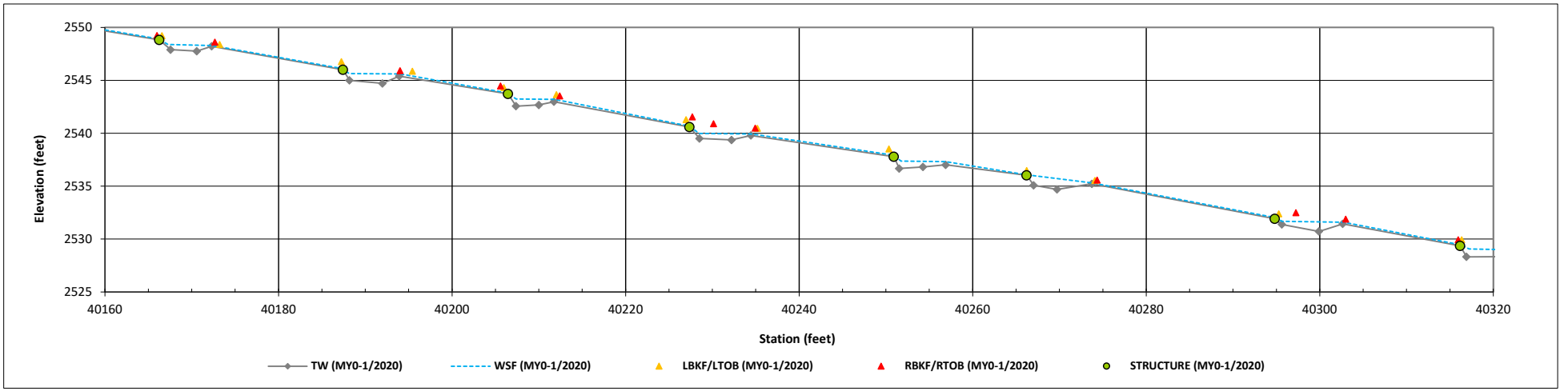
UT4 (STA 400+00 to 403+20)





Longitudinal Profile Plots

Shake Rag Mitigation Site
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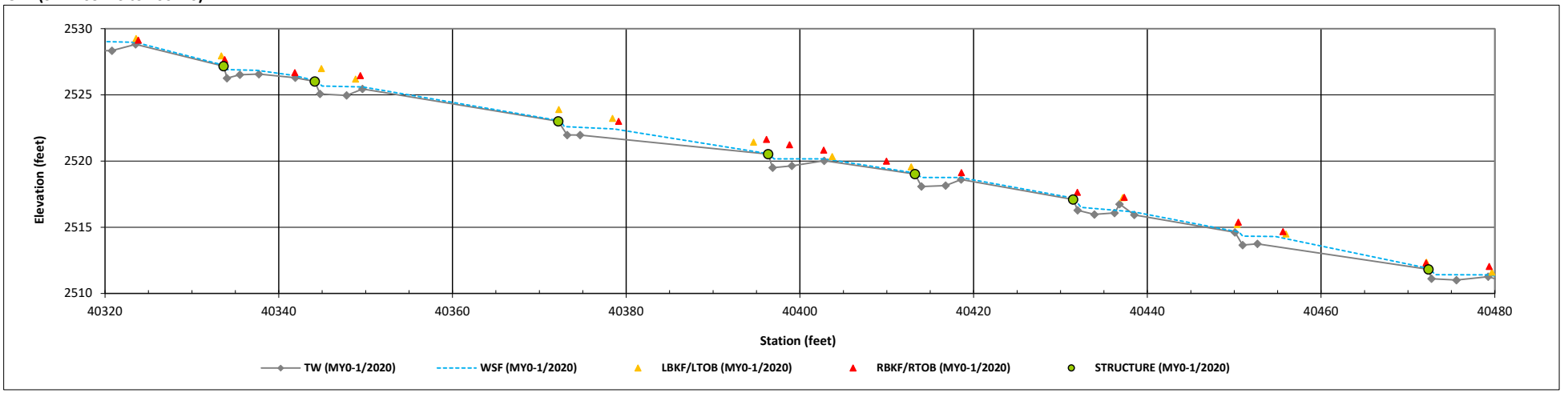
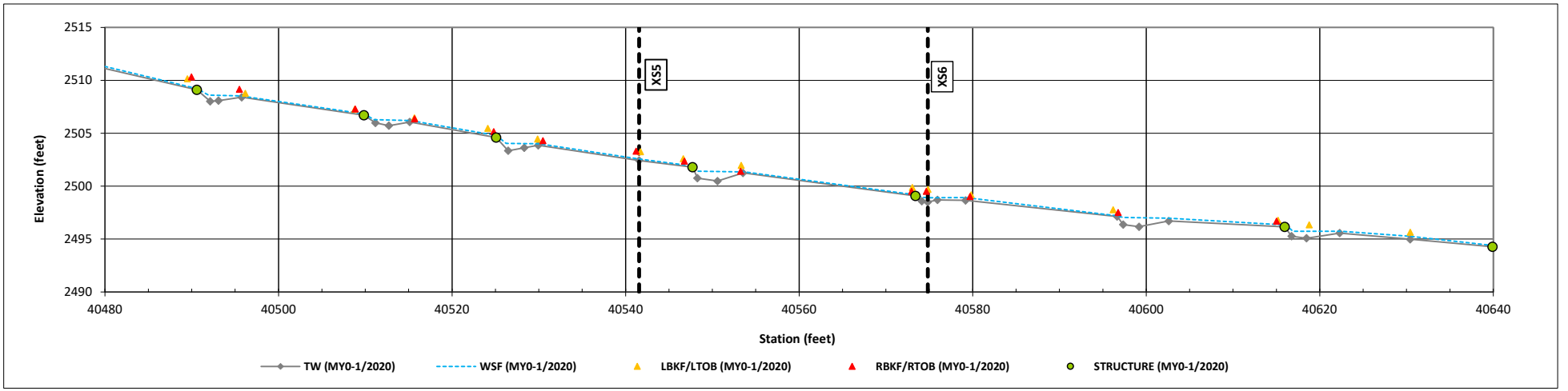
UT4 (STA 403+20 to 406+40)





Longitudinal Profile Plots

Shake Rag Mitigation Site
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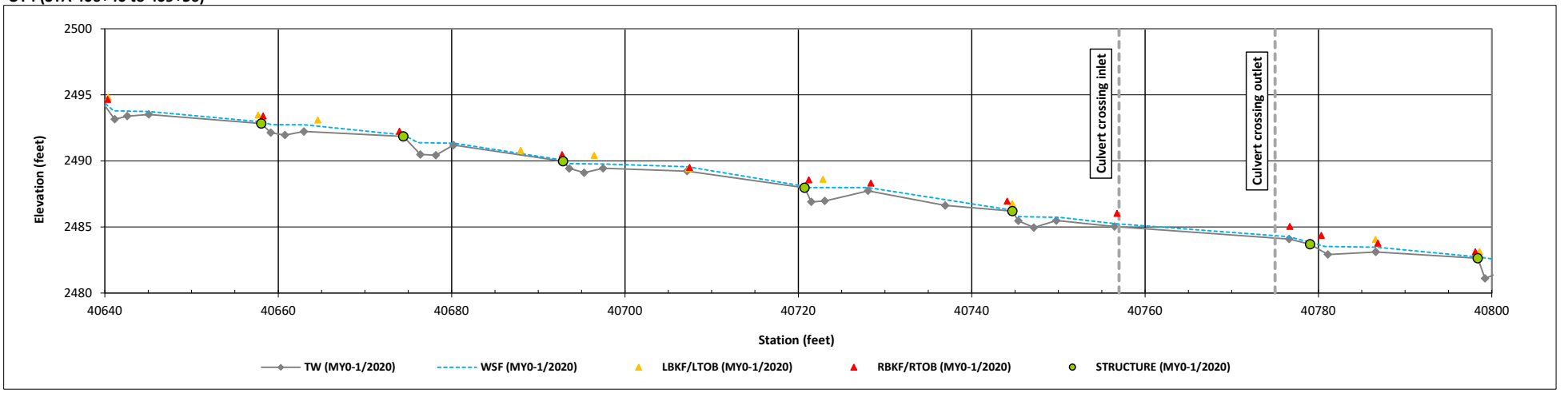
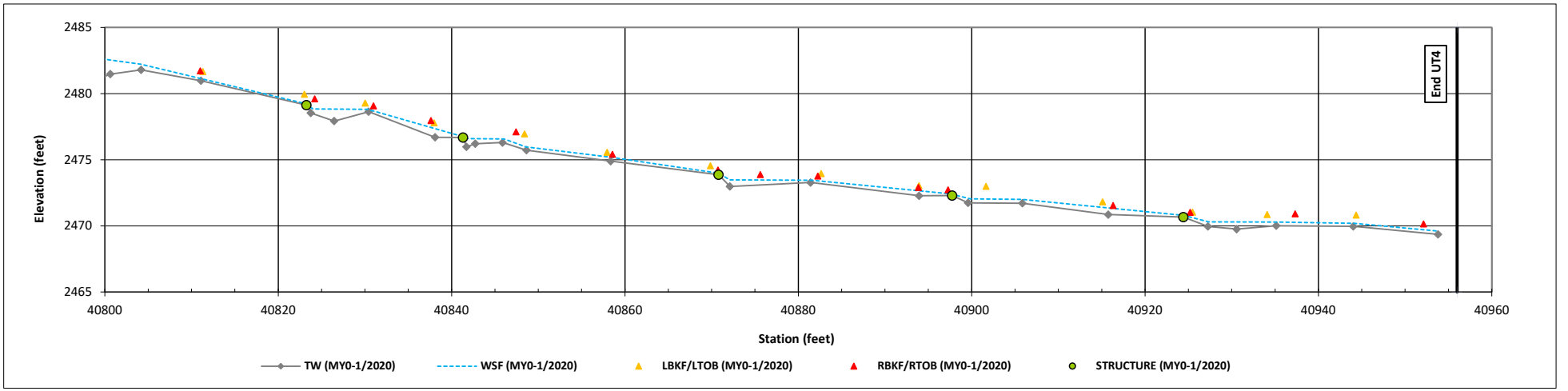
UT4 (STA 406+40 to 409+56)





Longitudinal Profile Plots

Shake Rag Mitigation Site
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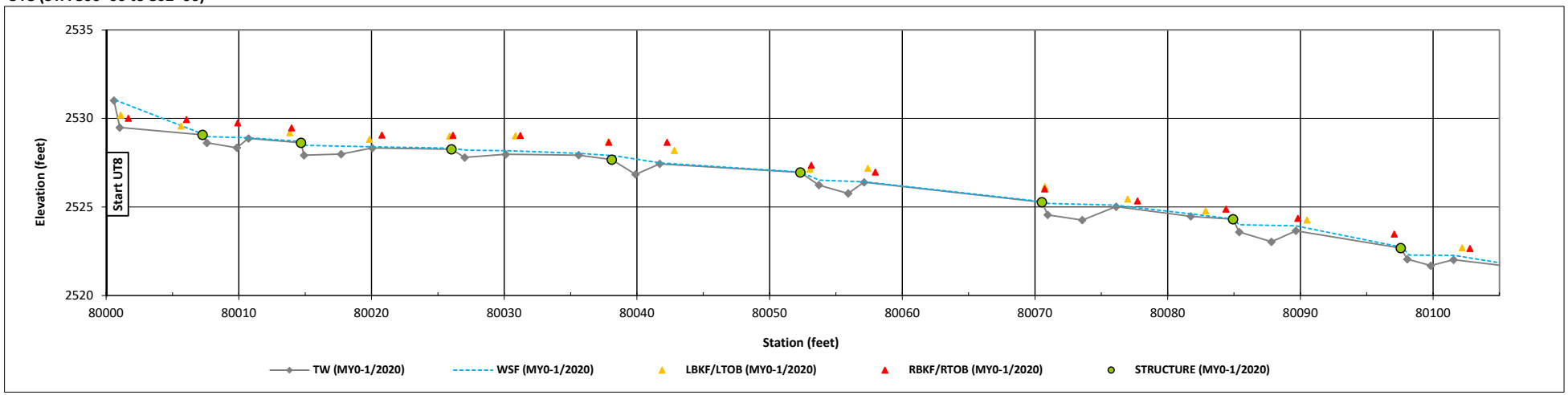
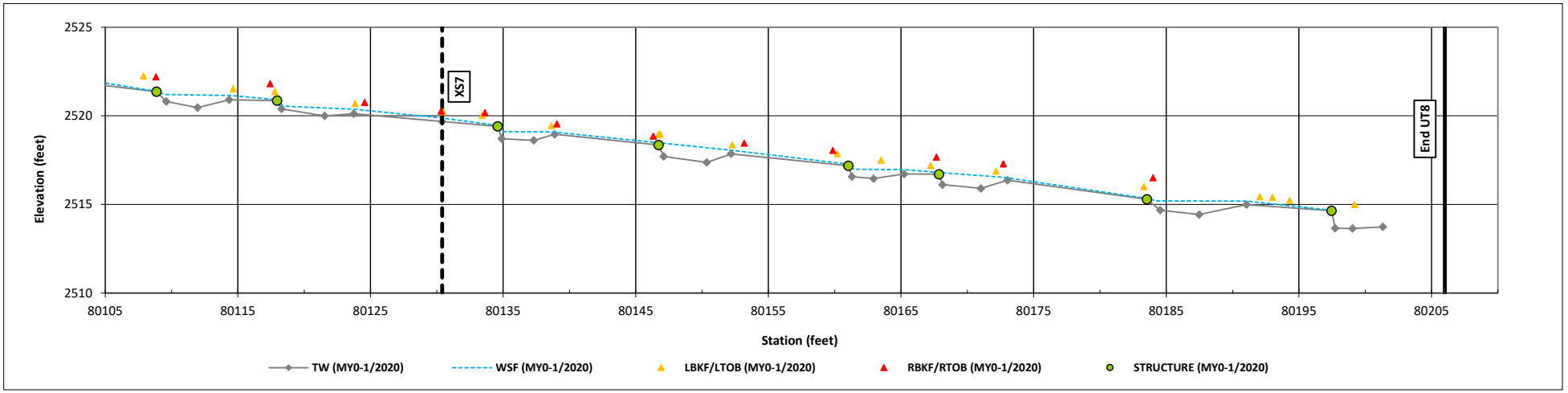
UT8 (STA 800+00 to 802+06)





Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
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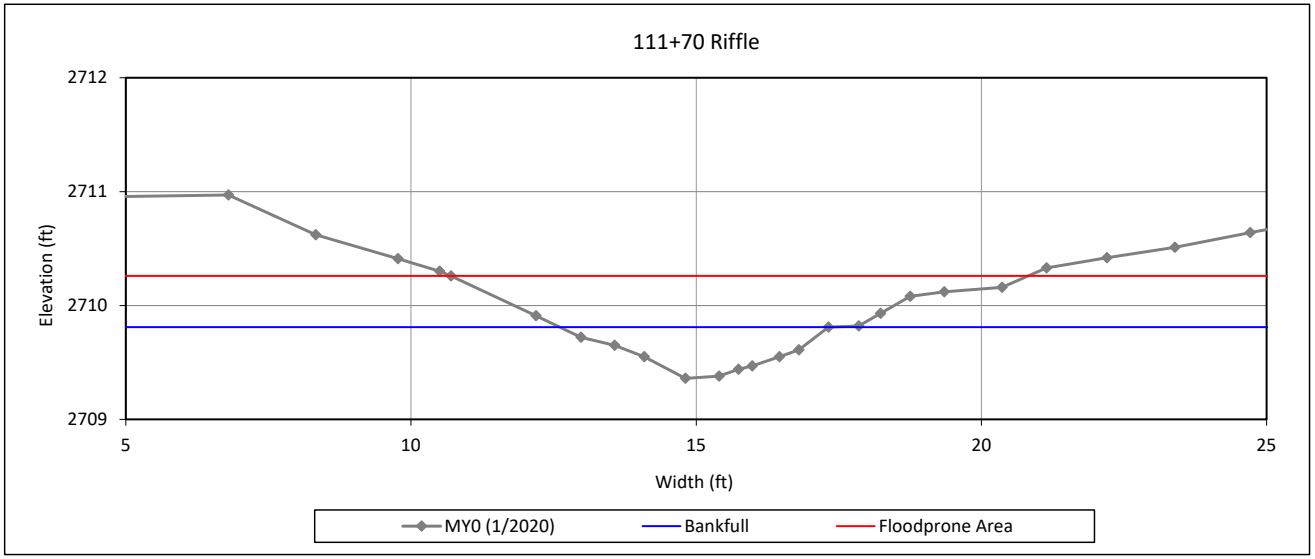
Cross-Section 1-UT1 Reach 2



Bankfull Dimensions	
1.2	x-section area (ft.sq.)
4.7	width (ft)
0.3	mean depth (ft)
0.4	max depth (ft)
4.8	wetted perimeter (ft)
0.3	hydraulic radius (ft)
18.4	width-depth ratio
10.1	W flood prone area (ft)
2.1	entrenchment ratio
1.0	low bank height ratio

Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
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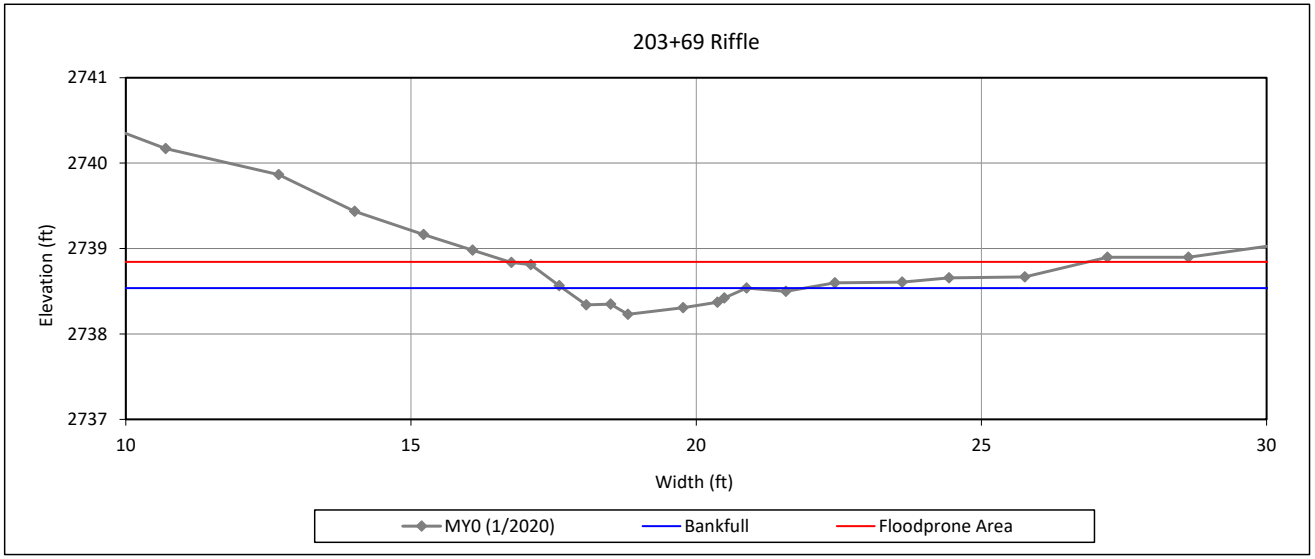
Cross-Section 2-UT2 Reach 2



Bankfull Dimensions	
0.6	x-section area (ft.sq.)
3.2	width (ft)
0.2	mean depth (ft)
0.3	max depth (ft)
3.3	wetted perimeter (ft)
0.2	hydraulic radius (ft)
16.9	width-depth ratio
10.1	W flood prone area (ft)
3.1	entrenchment ratio
1.0	low bank height ratio

Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
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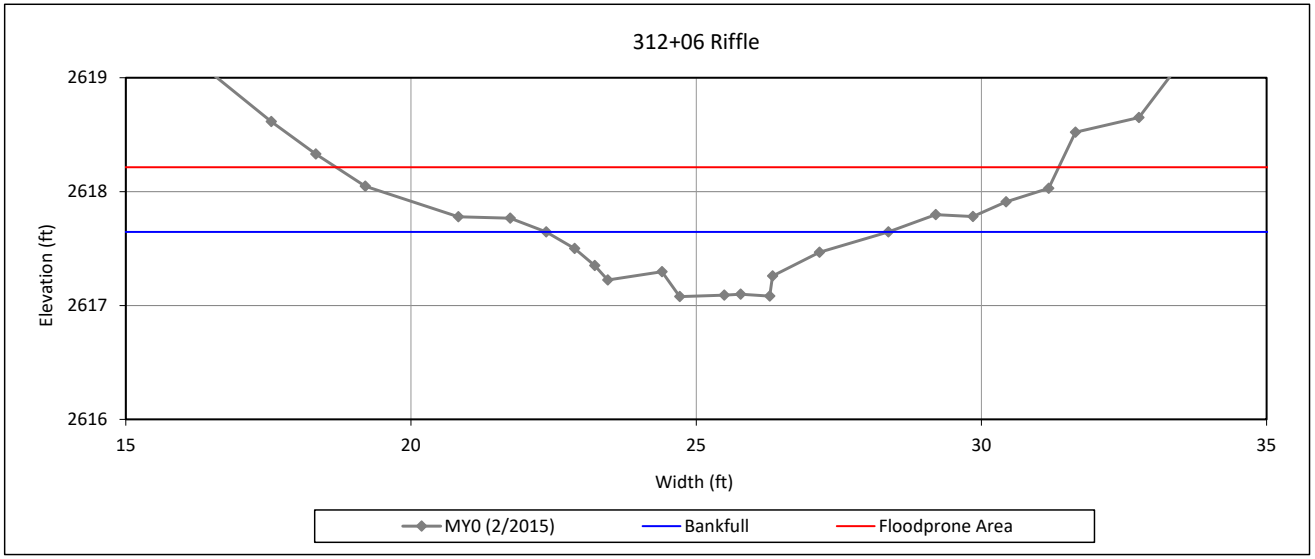
Monitoring Year 0 - 2020

Cross-Section 3-UT3 Reach 2



Bankfull Dimensions	
1.9	x-section area (ft.sq.)
6.0	width (ft)
0.3	mean depth (ft)
0.6	max depth (ft)
6.3	wetted perimeter (ft)
0.3	hydraulic radius (ft)
18.4	width-depth ratio
12.7	W flood prone area (ft)
2.1	entrenchment ratio
1.0	low bank height ratio

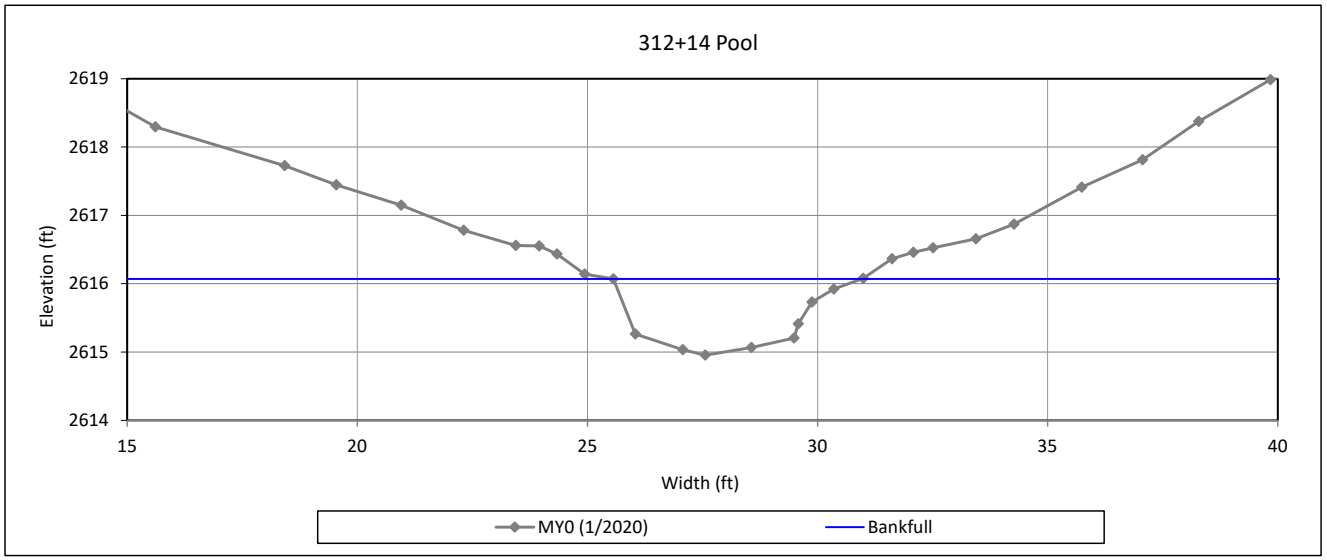
Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 0 - 2020

Cross-Section 4-UT3 Reach 2



Bankfull Dimensions	
4.0	x-section area (ft.sq.)
5.4	width (ft)
0.7	mean depth (ft)
1.1	max depth (ft)
6.2	wetted perimeter (ft)
0.6	hydraulic radius (ft)
7.3	width-depth ratio

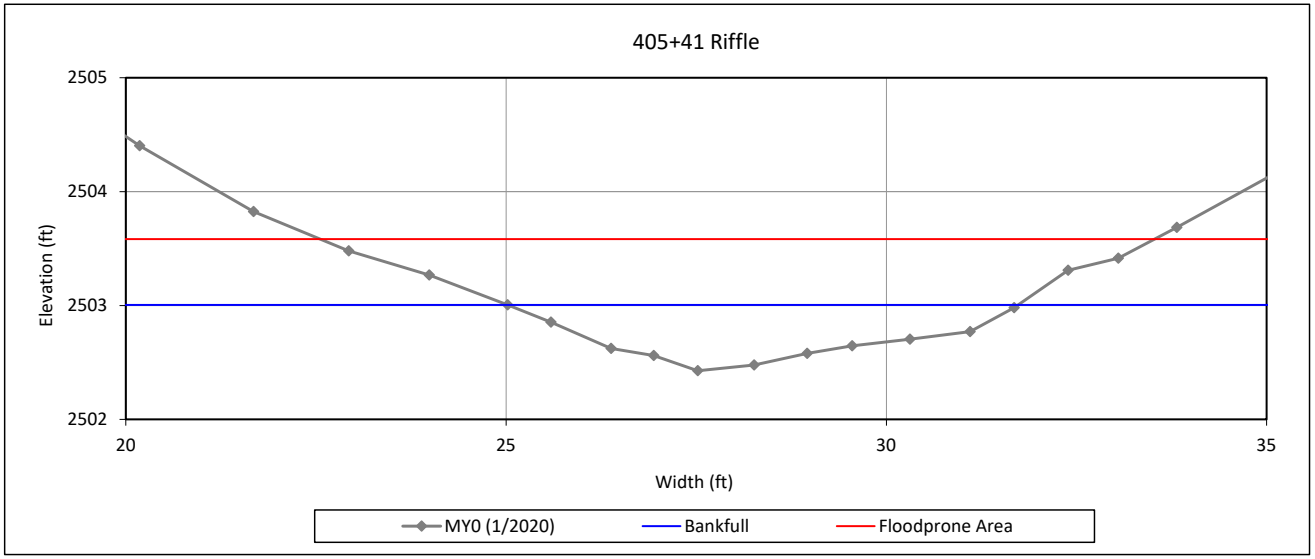
Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 0 - 2020

Cross-Section 5-UT4



Bankfull Dimensions	
2.3	x-section area (ft.sq.)
6.7	width (ft)
0.3	mean depth (ft)
0.6	max depth (ft)
6.8	wetted perimeter (ft)
0.3	hydraulic radius (ft)
19.7	width-depth ratio
11.0	W flood prone area (ft)
1.6	entrenchment ratio
1.0	low bank height ratio

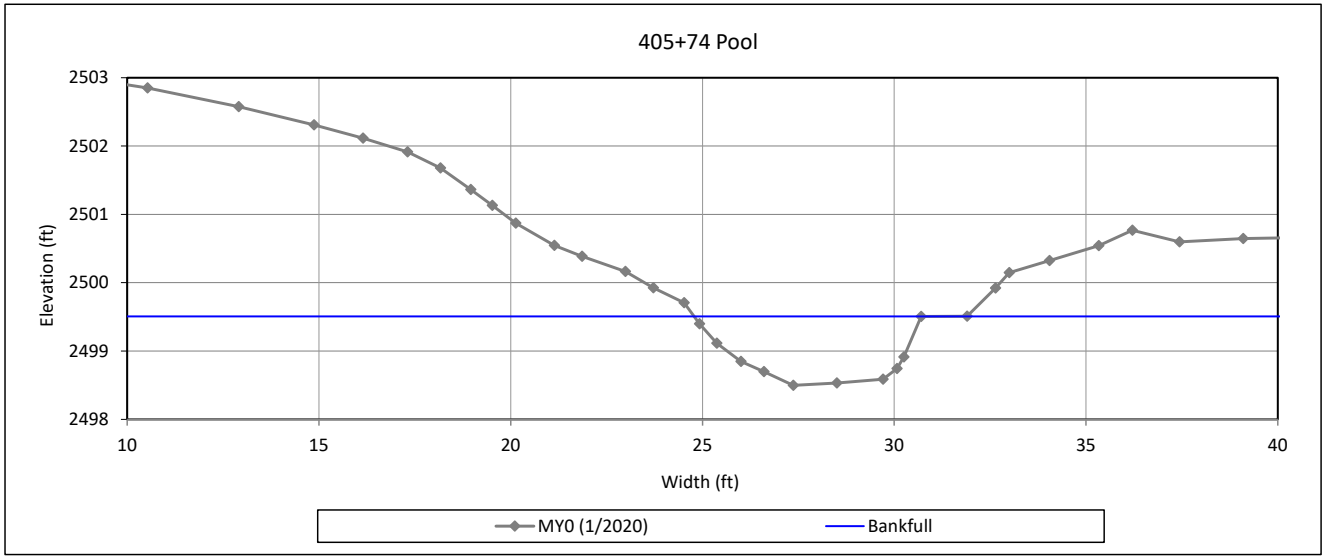
Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 0 - 2020

Cross-Section 6-UT4



Bankfull Dimensions	
4.4	x-section area (ft.sq.)
5.9	width (ft)
0.7	mean depth (ft)
1.0	max depth (ft)
6.5	wetted perimeter (ft)
0.7	hydraulic radius (ft)
7.9	width-depth ratio

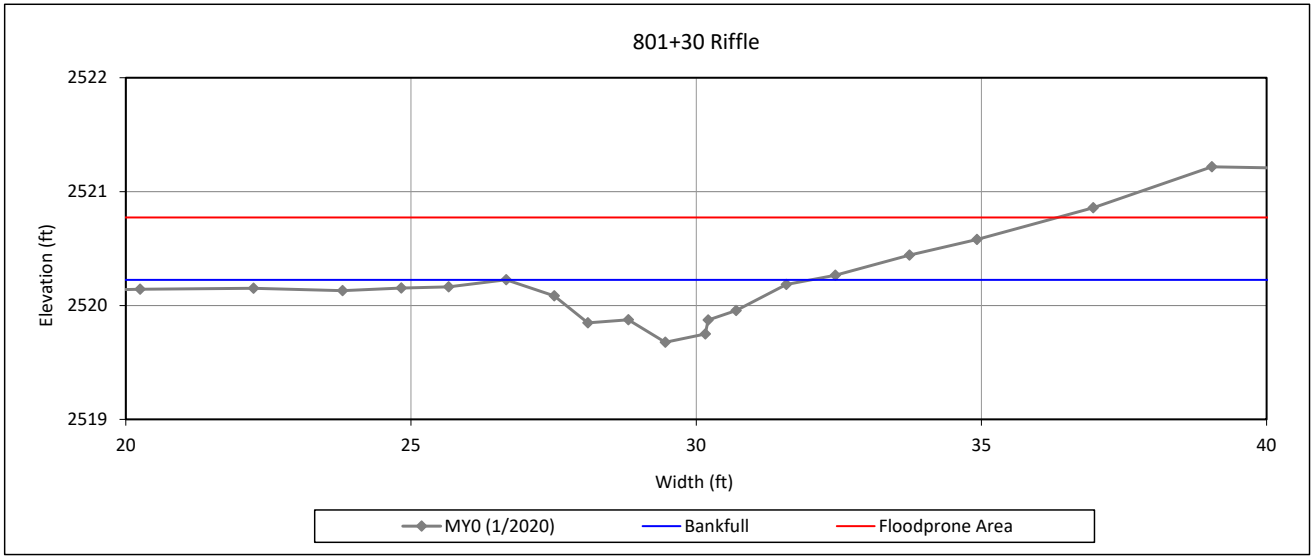
Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 0 - 2020

Cross-Section 7-UT8



Bankfull Dimensions	
1.4	x-section area (ft.sq.)
5.3	width (ft)
0.3	mean depth (ft)
0.5	max depth (ft)
5.6	wetted perimeter (ft)
0.3	hydraulic radius (ft)
19.9	width-depth ratio
36.3	W flood prone area (ft)
6.8	entrenchment ratio
1.0	low bank height ratio

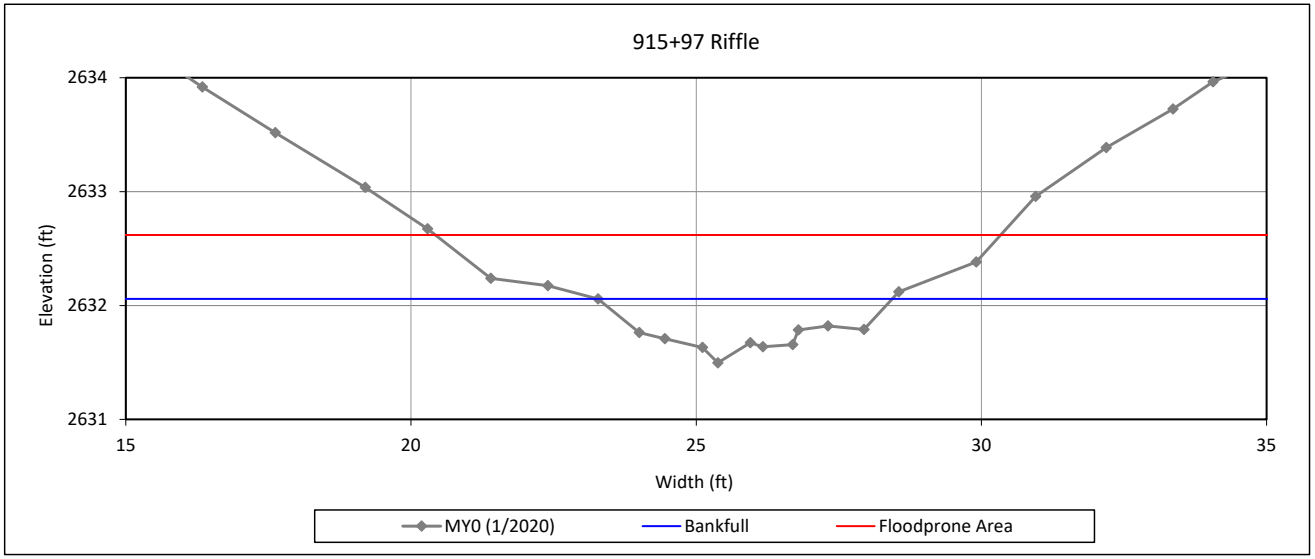
Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 0 - 2020

Cross-Section 8-Shake Rag Branch Reach 3



Bankfull Dimensions	
1.6	x-section area (ft.sq.)
5.2	width (ft)
0.3	mean depth (ft)
0.6	max depth (ft)
5.4	wetted perimeter (ft)
0.3	hydraulic radius (ft)
16.6	width-depth ratio
9.9	W flood prone area (ft)
1.9	entrenchment ratio
1.0	low bank height ratio

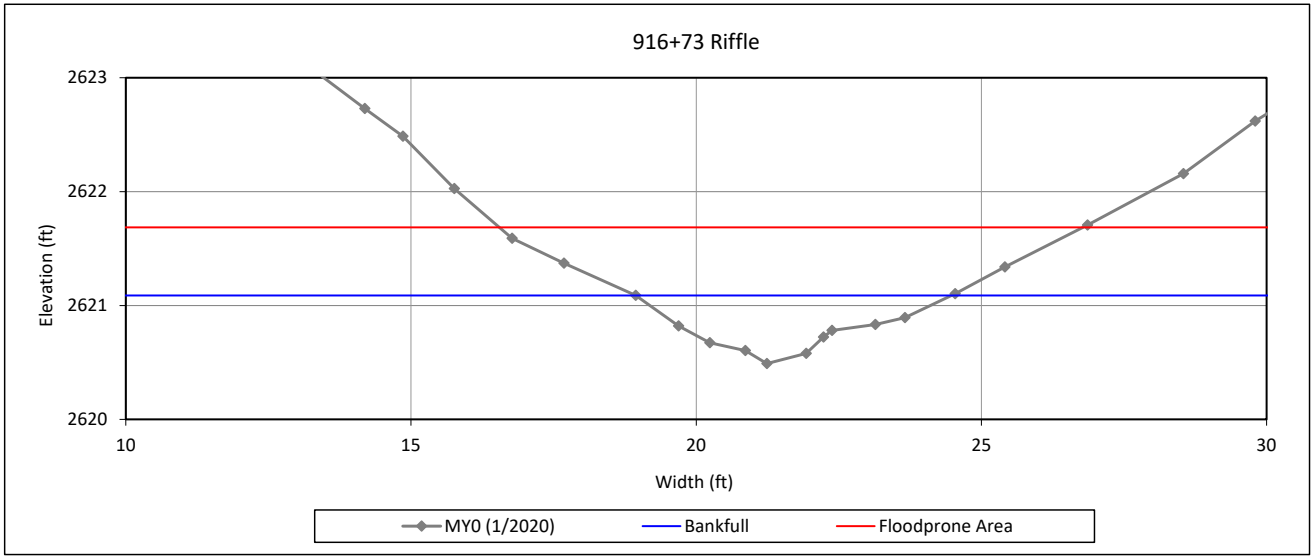
Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 0 - 2020

Cross-Section 9-Shake Rag Branch Reach 3



Bankfull Dimensions	
1.7	x-section area (ft.sq.)
5.5	width (ft)
0.3	mean depth (ft)
0.6	max depth (ft)
5.7	wetted perimeter (ft)
0.3	hydraulic radius (ft)
17.5	width-depth ratio
10.2	W flood prone area (ft)
1.8	entrenchment ratio
1.0	low bank height ratio

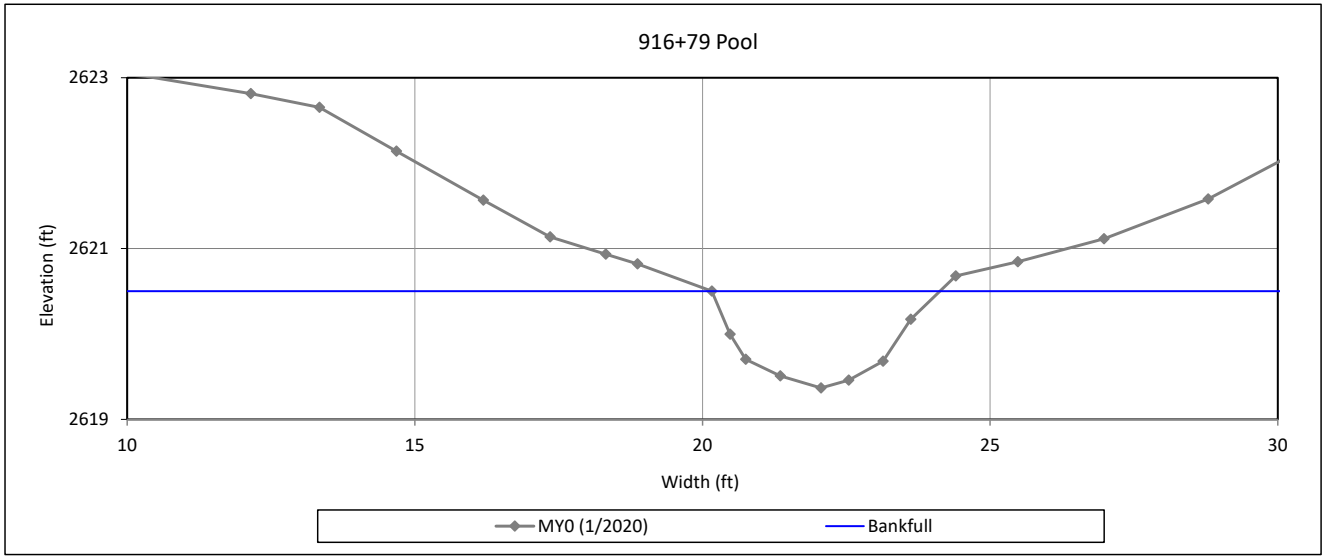
Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 0 - 2020

Cross-Section 10-Shake Rag Branch Reach 3



Bankfull Dimensions	
3.0	x-section area (ft.sq.)
4.0	width (ft)
0.8	mean depth (ft)
1.1	max depth (ft)
4.8	wetted perimeter (ft)
0.6	hydraulic radius (ft)
5.3	width-depth ratio

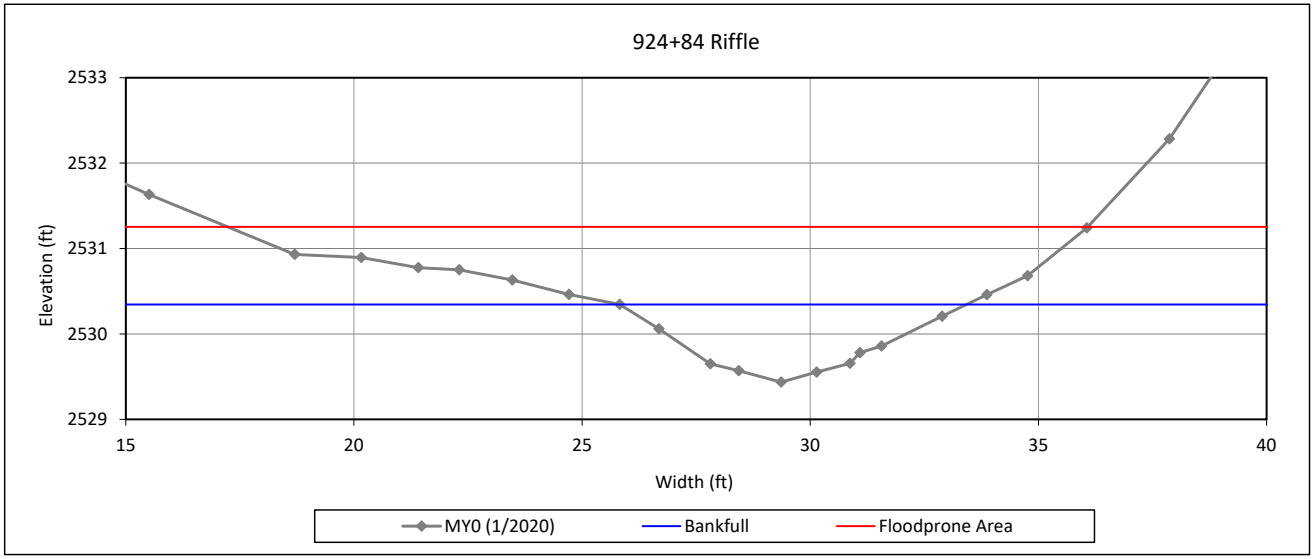
Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 0 - 2020

Cross-Section 11-Shake Rag Branch Reach 4



Bankfull Dimensions	
4.0	x-section area (ft.sq.)
7.6	width (ft)
0.5	mean depth (ft)
0.9	max depth (ft)
7.9	wetted perimeter (ft)
0.5	hydraulic radius (ft)
14.6	width-depth ratio
18.9	W flood prone area (ft)
2.5	entrenchment ratio
1.0	low bank height ratio

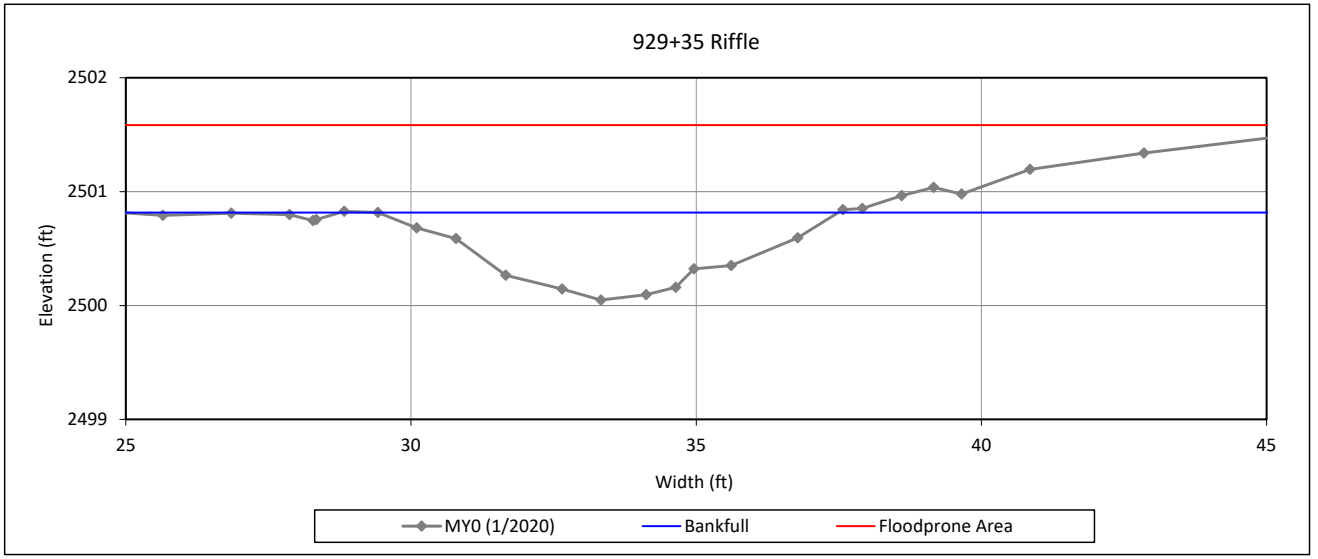
Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 0 - 2020

Cross-Section 12-Shake Rag Branch Reach 5



Bankfull Dimensions	
3.5	x-section area (ft.sq.)
8.1	width (ft)
0.4	mean depth (ft)
0.8	max depth (ft)
8.3	wetted perimeter (ft)
0.4	hydraulic radius (ft)
18.4	width-depth ratio
46.4	W flood prone area (ft)
5.8	entrenchment ratio
1.0	low bank height ratio

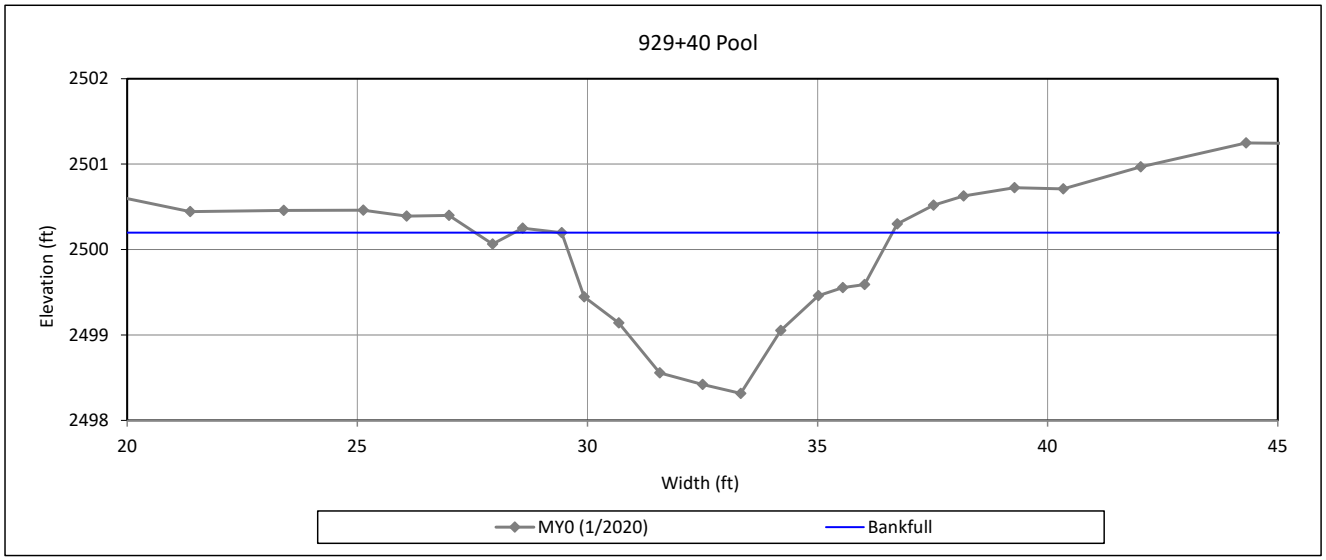
Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 0 - 2020

Cross-Section 13-Shake Rag Branch Reach 5



Bankfull Dimensions	
8.1	x-section area (ft.sq.)
7.2	width (ft)
1.1	mean depth (ft)
1.9	max depth (ft)
8.5	wetted perimeter (ft)
1.0	hydraulic radius (ft)
6.4	width-depth ratio

Survey Date: 1/2020
Field Crew: Kee Surveying

View Downstream

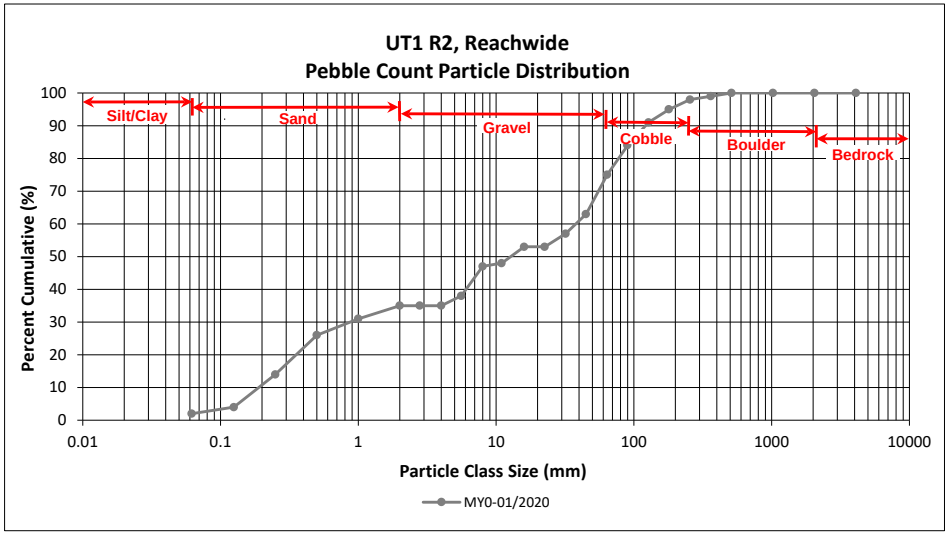
Reachwide and Cross-Section Pebble Count Plots

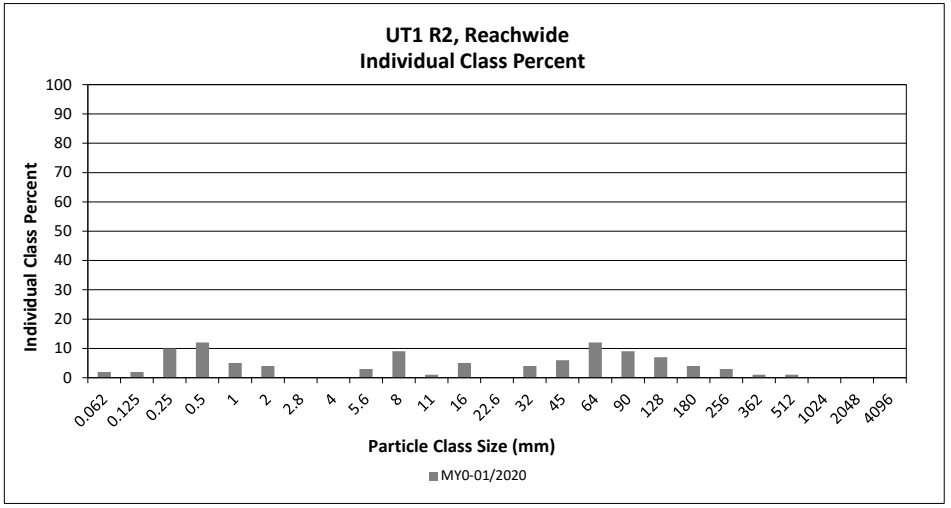
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT1 R2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		2	2	2	2
SAND	Very fine	0.062	0.125		2	2	2	4
	Fine	0.125	0.250	2	8	10	10	14
	Medium	0.25	0.50	1	11	12	12	26
	Coarse	0.5	1.0		5	5	5	31
	Very Coarse	1.0	2.0	1	3	4	4	35
GRAVEL	Very Fine	2.0	2.8					35
	Very Fine	2.8	4.0					35
	Fine	4.0	5.6		3	3	3	38
	Fine	5.6	8.0	4	5	9	9	47
	Medium	8.0	11.0	1		1	1	48
	Medium	11.0	16.0	3	2	5	5	53
	Coarse	16.0	22.6					53
	Coarse	22.6	32	2	2	4	4	57
	Very Coarse	32	45	4	2	6	6	63
	Very Coarse	45	64	11	1	12	12	75
COBBLE	Small	64	90	6	3	9	9	84
	Small	90	128	7		7	7	91
	Large	128	180	4		4	4	95
	Large	180	256	3		3	3	98
BOULDER	Small	256	362		1	1	1	99
	Small	362	512	1		1	1	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.3
D_{35} =	2.0
D_{50} =	12.8
D_{84} =	90.0
D_{95} =	180.0
D_{100} =	512.0





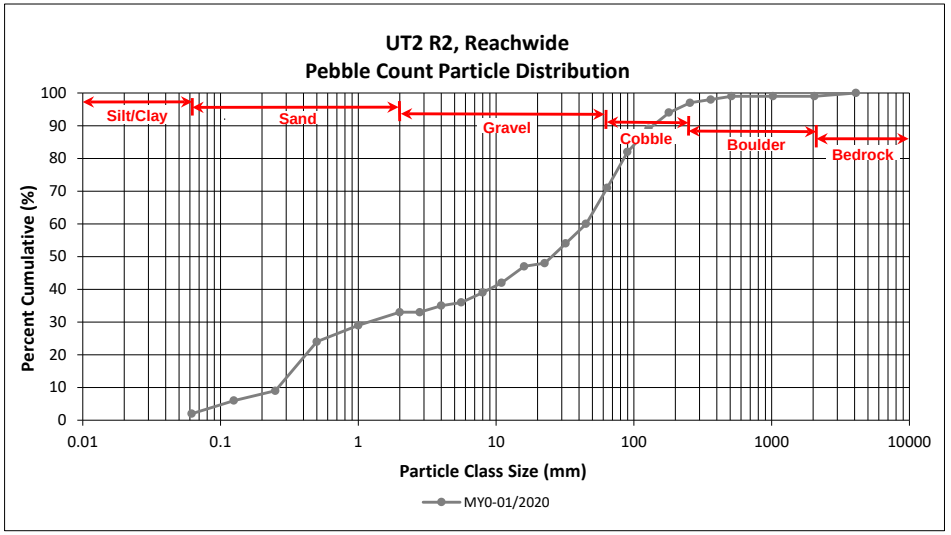
Reachwide and Cross-Section Pebble Count Plots

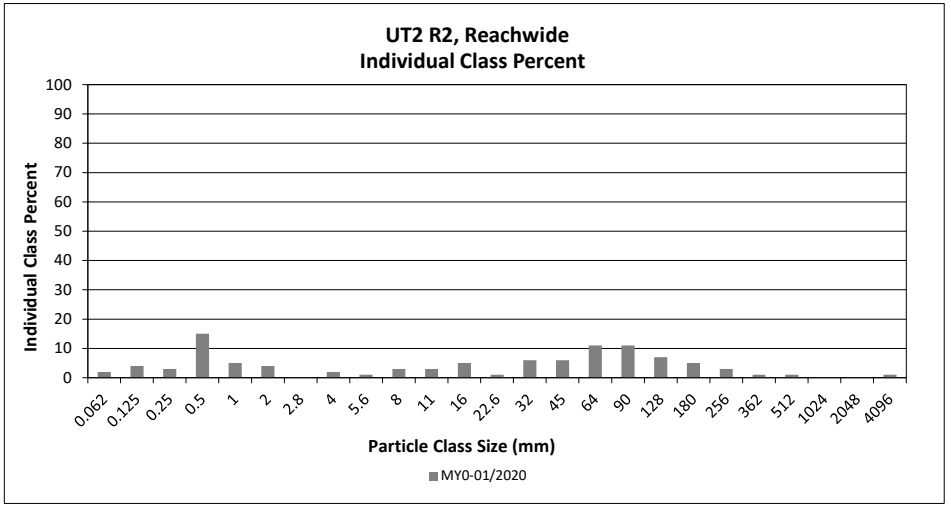
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT2 R2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		2	2	2	2
SAND	Very fine	0.062	0.125		4	4	4	6
	Fine	0.125	0.250		3	3	3	9
	Medium	0.25	0.50	2	13	15	15	24
	Coarse	0.5	1.0		5	5	5	29
	Very Coarse	1.0	2.0		4	4	4	33
GRAVEL	Very Fine	2.0	2.8					33
	Very Fine	2.8	4.0		2	2	2	35
	Fine	4.0	5.6	1		1	1	36
	Fine	5.6	8.0		3	3	3	39
	Medium	8.0	11.0		3	3	3	42
	Medium	11.0	16.0	2	3	5	5	47
	Coarse	16.0	22.6	1		1	1	48
	Coarse	22.6	32	3	3	6	6	54
	Very Coarse	32	45	6		6	6	60
	Very Coarse	45	64	10	1	11	11	71
COBBLE	Small	64	90	9	2	11	11	82
	Small	90	128	6	1	7	7	89
	Large	128	180	5		5	5	94
	Large	180	256	2	1	3	3	97
BOULDER	Small	256	362	1		1	1	98
	Small	362	512	1		1	1	99
	Medium	512	1024					99
	Large/Very Large	1024	2048					99
BEDROCK	Bedrock	2048	>2048	1		1	1	100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.3
D_{35} =	4.0
D_{50} =	25.4
D_{84} =	99.5
D_{95} =	202.4
D_{100} =	>2048





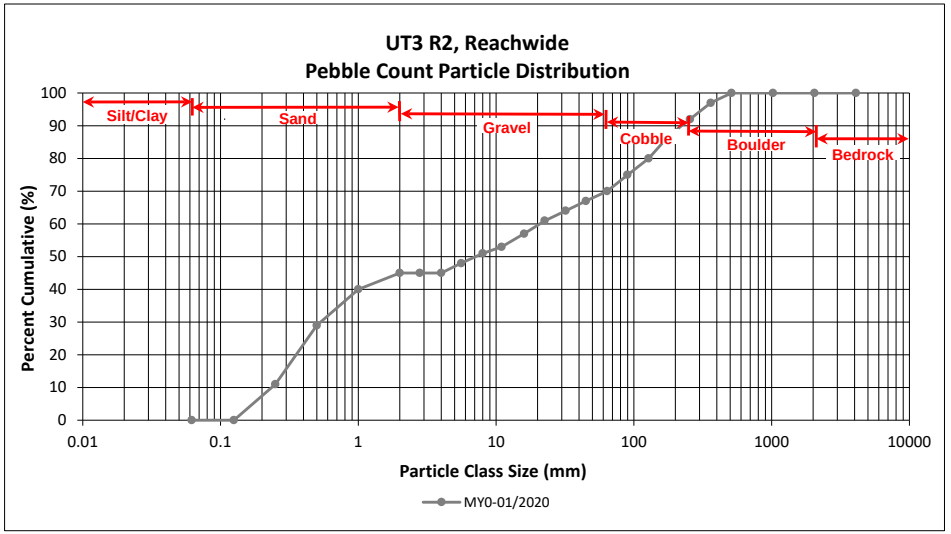
Reachwide and Cross-Section Pebble Count Plots

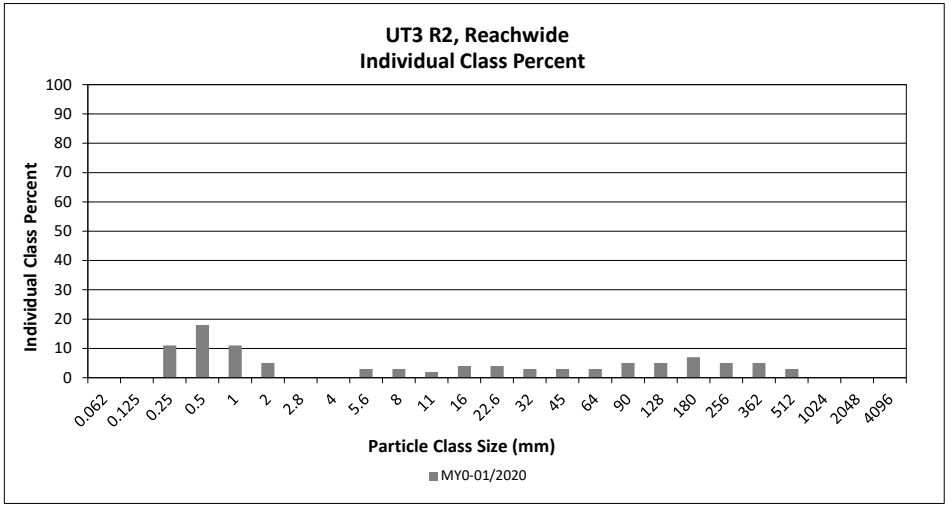
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT3 R2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062					0
SAND	Very fine	0.062	0.125					0
	Fine	0.125	0.250		11	11	11	11
	Medium	0.25	0.50	4	14	18	18	29
	Coarse	0.5	1.0	1	10	11	11	40
	Very Coarse	1.0	2.0		5	5	5	45
GRAVEL	Very Fine	2.0	2.8					45
	Very Fine	2.8	4.0					45
	Fine	4.0	5.6	2	1	3	3	48
	Fine	5.6	8.0	1	2	3	3	51
	Medium	8.0	11.0		2	2	2	53
	Medium	11.0	16.0	3	1	4	4	57
	Coarse	16.0	22.6	2	2	4	4	61
	Coarse	22.6	32	2	1	3	3	64
	Very Coarse	32	45	3		3	3	67
	Very Coarse	45	64	2	1	3	3	70
COBBLE	Small	64	90	5		5	5	75
	Small	90	128	5		5	5	80
	Large	128	180	7		7	7	87
	Large	180	256	5		5	5	92
BOULDER	Small	256	362	5		5	5	97
	Small	362	512	3		3	3	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.3
D_{35} =	0.7
D_{50} =	7.1
D_{84} =	155.5
D_{95} =	315.2
D_{100} =	512.0





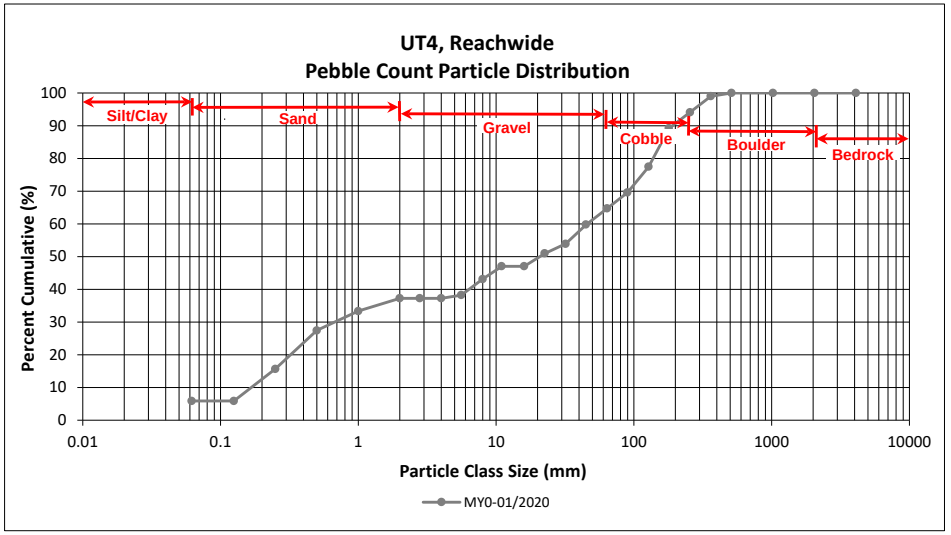
Reachwide and Cross-Section Pebble Count Plots

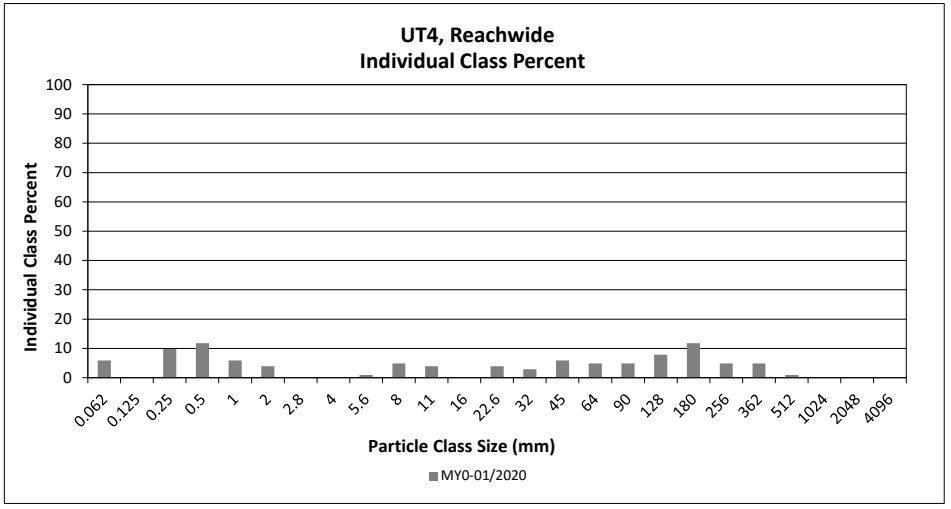
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT4, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		6	6	6	6
SAND	Very fine	0.062	0.125					6
	Fine	0.125	0.250	2	8	10	10	16
	Medium	0.25	0.50	3	9	12	12	27
	Coarse	0.5	1.0		6	6	6	33
	Very Coarse	1.0	2.0		4	4	4	37
GRAVEL	Very Fine	2.0	2.8					37
	Very Fine	2.8	4.0					37
	Fine	4.0	5.6		1	1	1	38
	Fine	5.6	8.0	1	4	5	5	43
	Medium	8.0	11.0	2	2	4	4	47
	Medium	11.0	16.0					47
	Coarse	16.0	22.6	4		4	4	51
	Coarse	22.6	32	1	2	3	3	54
	Very Coarse	32	45	3	3	6	6	60
	Very Coarse	45	64	4	1	5	5	65
COBBLE	Small	64	90	4	1	5	5	70
	Small	90	128	7	1	8	8	77
	Large	128	180	9	3	12	12	89
	Large	180	256	5		5	5	94
BOULDER	Small	256	362	5		5	5	99
	Small	362	512	1		1	1	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**51**	**51**	**102**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.3
D_{35} =	1.3
D_{50} =	20.7
D_{84} =	154.8
D_{95} =	272.5
D_{100} =	512.0





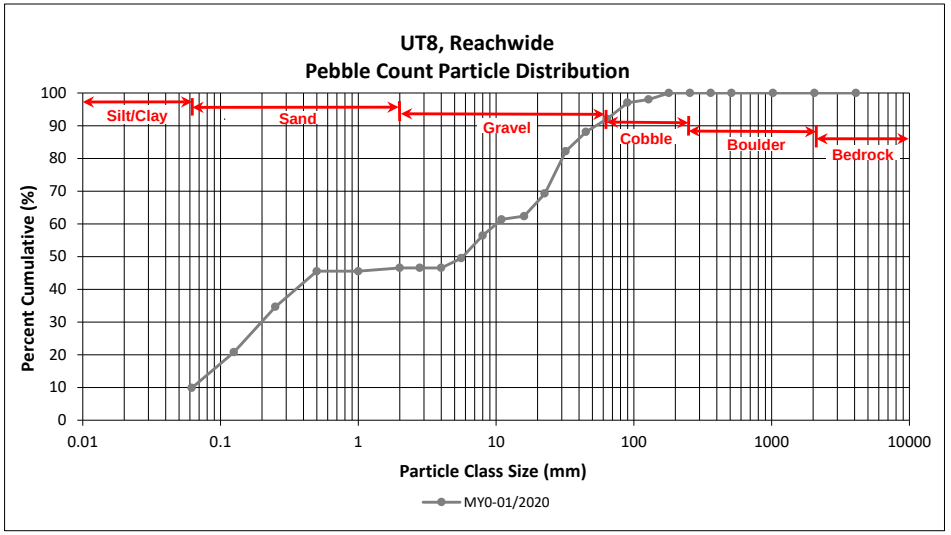
Reachwide and Cross-Section Pebble Count Plots

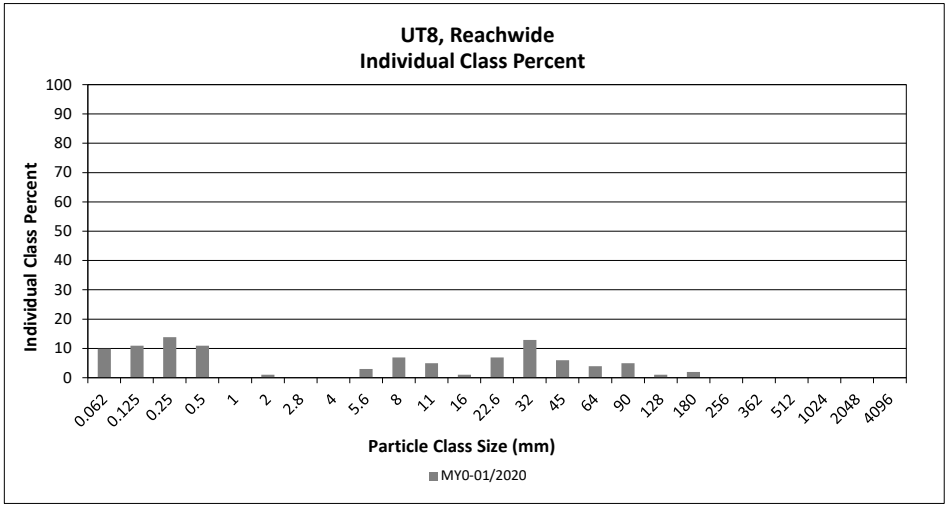
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT8, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	4	6	10	10	10
SAND	Very fine	0.062	0.125		11	11	11	21
	Fine	0.125	0.250	2	12	14	14	35
	Medium	0.25	0.50	4	7	11	11	46
	Coarse	0.5	1.0					46
	Very Coarse	1.0	2.0		1	1	1	47
GRAVEL	Very Fine	2.0	2.8					47
	Very Fine	2.8	4.0					47
	Fine	4.0	5.6	1	2	3	3	50
	Fine	5.6	8.0	4	3	7	7	56
	Medium	8.0	11.0	3	2	5	5	61
	Medium	11.0	16.0	1		1	1	62
	Coarse	16.0	22.6	6	1	7	7	69
	Coarse	22.6	32	10	3	13	13	82
	Very Coarse	32	45	6		6	6	88
	Very Coarse	45	64	2	2	4	4	92
COBBLE	Small	64	90	5		5	5	97
	Small	90	128	1		1	1	98
	Large	128	180	2		2	2	100
	Large	180	256					100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	51	50	101	100	100

Reachwide	
Channel materials (mm)	
D_{16} =	0.1
D_{35} =	0.3
D_{50} =	5.7
D_{84} =	35.5
D_{95} =	78.3
D_{100} =	180.0





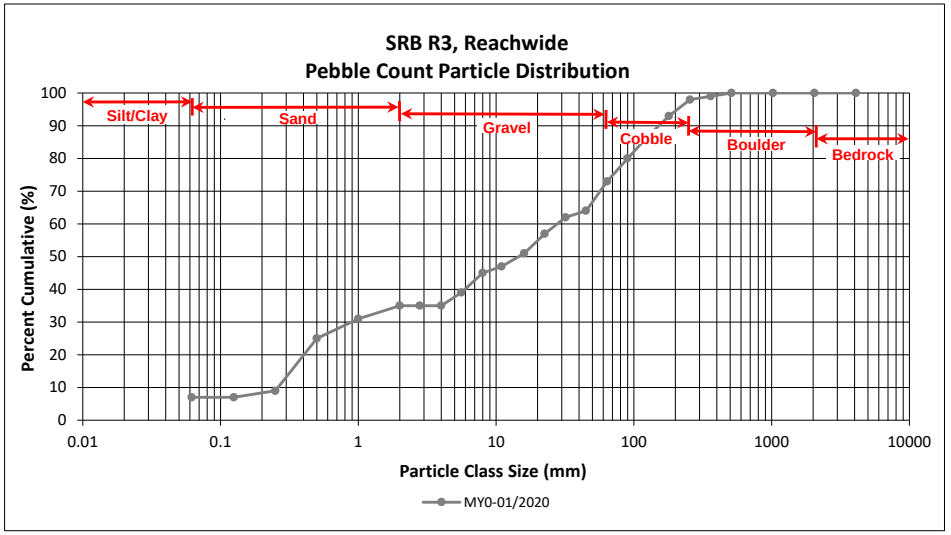
Reachwide and Cross-Section Pebble Count Plots

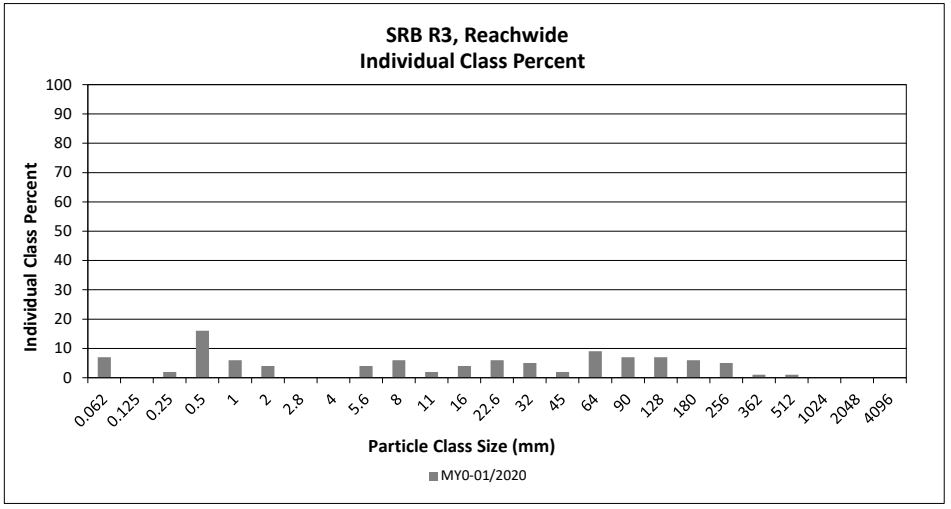
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

SRB R3, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	1	6	7	7	7
SAND	Very fine	0.062	0.125					7
	Fine	0.125	0.250		2	2	2	9
	Medium	0.25	0.50	2	14	16	16	25
	Coarse	0.5	1.0		6	6	6	31
	Very Coarse	1.0	2.0		4	4	4	35
GRAVEL	Very Fine	2.0	2.8					35
	Very Fine	2.8	4.0					35
	Fine	4.0	5.6		4	4	4	39
	Fine	5.6	8.0		6	6	6	45
	Medium	8.0	11.0	2		2	2	47
	Medium	11.0	16.0	4		4	4	51
	Coarse	16.0	22.6		6	6	6	57
	Coarse	22.6	32	5		5	5	62
	Very Coarse	32	45	2		2	2	64
	Very Coarse	45	64	7	2	9	9	73
COBBLE	Small	64	90	7		7	7	80
	Small	90	128	7		7	7	87
	Large	128	180	6		6	6	93
	Large	180	256	5		5	5	98
BOULDER	Small	256	362	1		1	1	99
	Small	362	512	1		1	1	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.3
D_{35} =	2.0
D_{50} =	14.6
D_{84} =	110.1
D_{95} =	207.2
D_{100} =	512.0





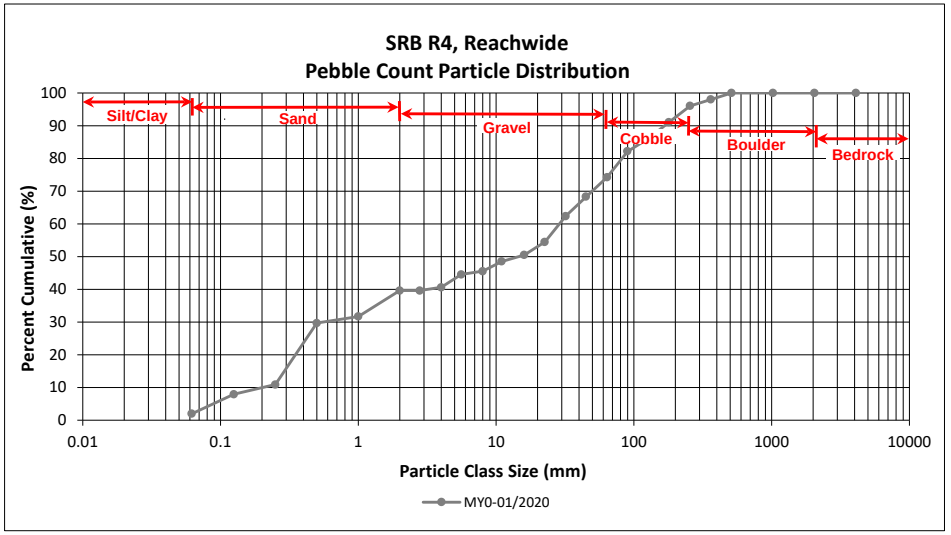
Reachwide and Cross-Section Pebble Count Plots

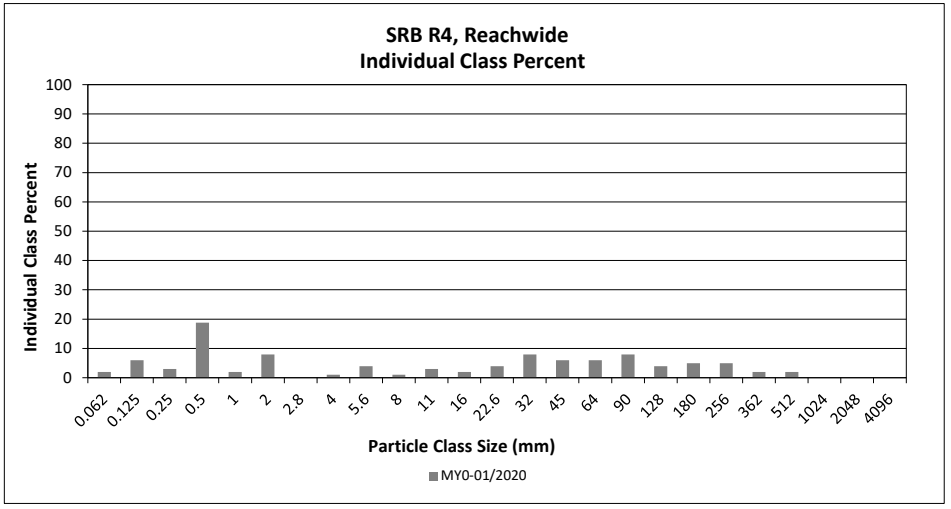
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

SRB R4, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		2	2	2	2
SAND	Very fine	0.062	0.125		6	6	6	8
	Fine	0.125	0.250		3	3	3	11
	Medium	0.25	0.50	1	18	19	19	30
	Coarse	0.5	1.0	2		2	2	32
	Very Coarse	1.0	2.0		8	8	8	40
GRAVEL	Very Fine	2.0	2.8					40
	Very Fine	2.8	4.0		1	1	1	41
	Fine	4.0	5.6	2	2	4	4	45
	Fine	5.6	8.0	1		1	1	46
	Medium	8.0	11.0	1	2	3	3	49
	Medium	11.0	16.0	1	1	2	2	50
	Coarse	16.0	22.6	4		4	4	54
	Coarse	22.6	32	4	4	8	8	62
	Very Coarse	32	45	6		6	6	68
	Very Coarse	45	64	4	2	6	6	74
COBBLE	Small	64	90	7	1	8	8	82
	Small	90	128	4		4	4	86
	Large	128	180	5		5	5	91
	Large	180	256	5		5	5	96
BOULDER	Small	256	362	2		2	2	98
	Small	362	512	2		2	2	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	51	50	101	100	100

Reachwide	
Channel materials (mm)	
D_{16} =	0.3
D_{35} =	1.3
D_{50} =	14.6
D_{84} =	105.8
D_{95} =	237.7
D_{100} =	512.0





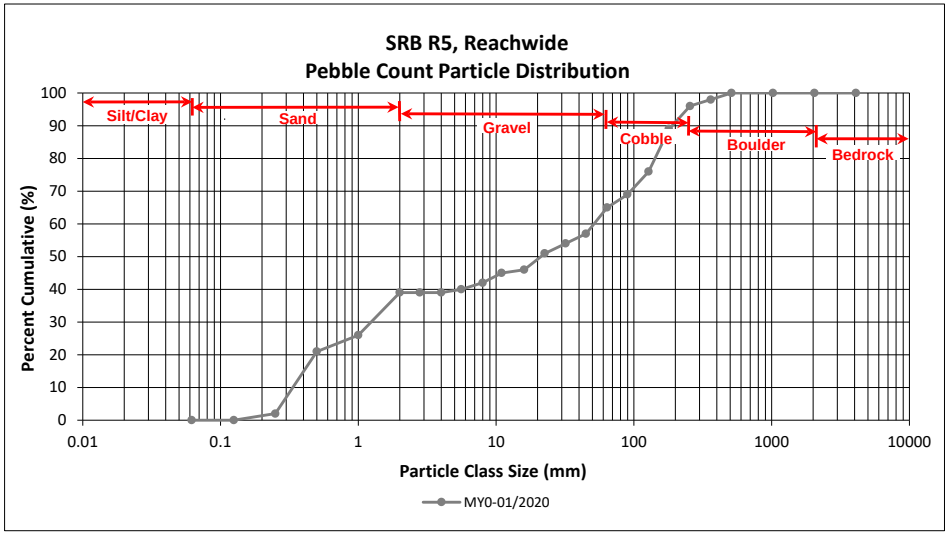
Reachwide and Cross-Section Pebble Count Plots

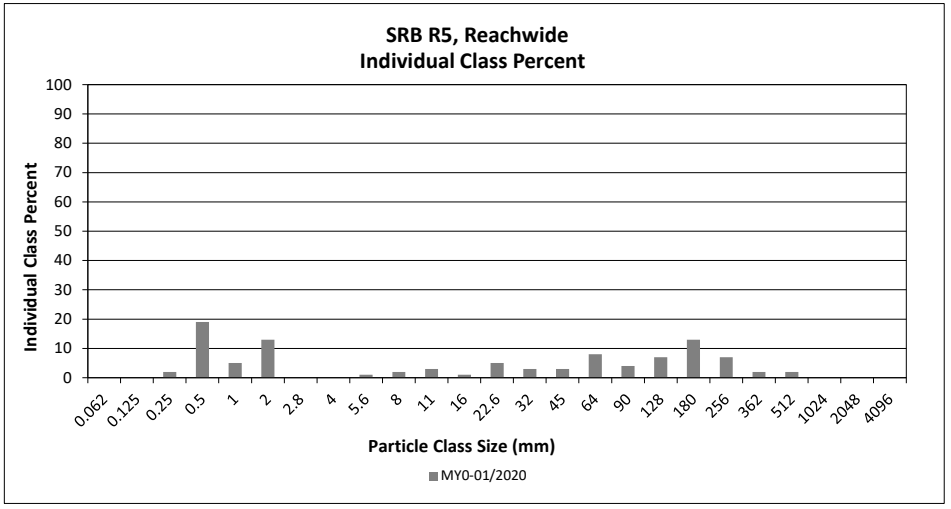
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

SRB R5, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062					0
SAND	Very fine	0.062	0.125					0
	Fine	0.125	0.250		2	2	2	2
	Medium	0.25	0.50	2	17	19	19	21
	Coarse	0.5	1.0		5	5	5	26
	Very Coarse	1.0	2.0	4	9	13	13	39
GRAVEL	Very Fine	2.0	2.8					39
	Very Fine	2.8	4.0					39
	Fine	4.0	5.6	1		1	1	40
	Fine	5.6	8.0		2	2	2	42
	Medium	8.0	11.0	1	2	3	3	45
	Medium	11.0	16.0	1		1	1	46
	Coarse	16.0	22.6	2	3	5	5	51
	Coarse	22.6	32	2	1	3	3	54
	Very Coarse	32	45	3		3	3	57
	Very Coarse	45	64	4	4	8	8	65
COBBLE	Small	64	90	2	2	4	4	69
	Small	90	128	7		7	7	76
	Large	128	180	11	2	13	13	89
	Large	180	256	6	1	7	7	96
BOULDER	Small	256	362	2		2	2	98
	Small	362	512	2		2	2	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	50	50	100	100	100

Reachwide	
Channel materials (mm)	
D_{16} =	0.4
D_{35} =	1.6
D_{50} =	21.1
D_{84} =	157.9
D_{95} =	243.4
D_{100} =	512.0





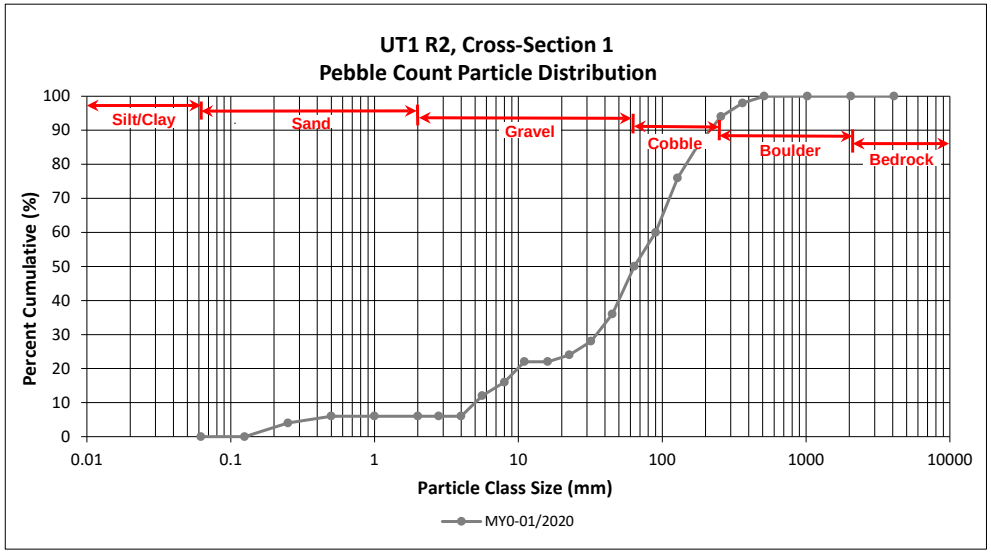
Reachwide and Cross-Section Pebble Count Plots

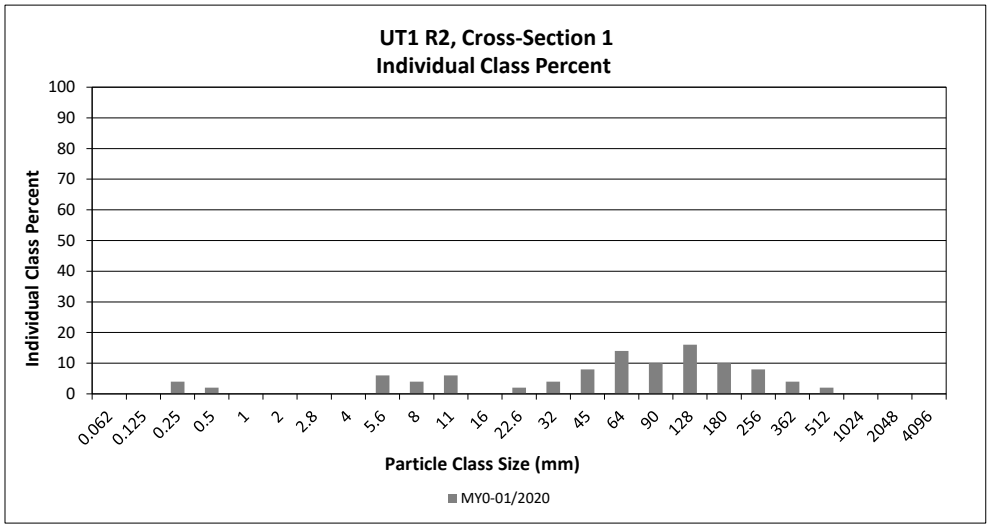
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT1 R2, Cross-Section 1

Particle Class		Diameter (mm) min	Diameter (mm) max	Riffle 100-Count	Summary: Class Percentage	Summary: Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250	4	4	4
	Medium	0.25	0.50	2	2	6
	Coarse	0.5	1.0			6
	Very Coarse	1.0	2.0			6
GRAVEL	Very Fine	2.0	2.8			6
	Very Fine	2.8	4.0			6
	Fine	4.0	5.6	6	6	12
	Fine	5.6	8.0	4	4	16
	Medium	8.0	11.0	6	6	22
	Medium	11.0	16.0			22
	Coarse	16.0	22.6	2	2	24
	Coarse	22.6	32	4	4	28
	Very Coarse	32	45	8	8	36
	Very Coarse	45	64	14	14	50
COBBLE	Small	64	90	10	10	60
	Small	90	128	16	16	76
	Large	128	180	10	10	86
	Large	180	256	8	8	94
BOULDER	Small	256	362	4	4	98
	Small	362	512	2	2	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 1	
Channel materials (mm)	
D_{16} =	8.0
D_{35} =	43.1
D_{50} =	64.0
D_{84} =	168.1
D_{95} =	279.2
D_{100} =	512.0





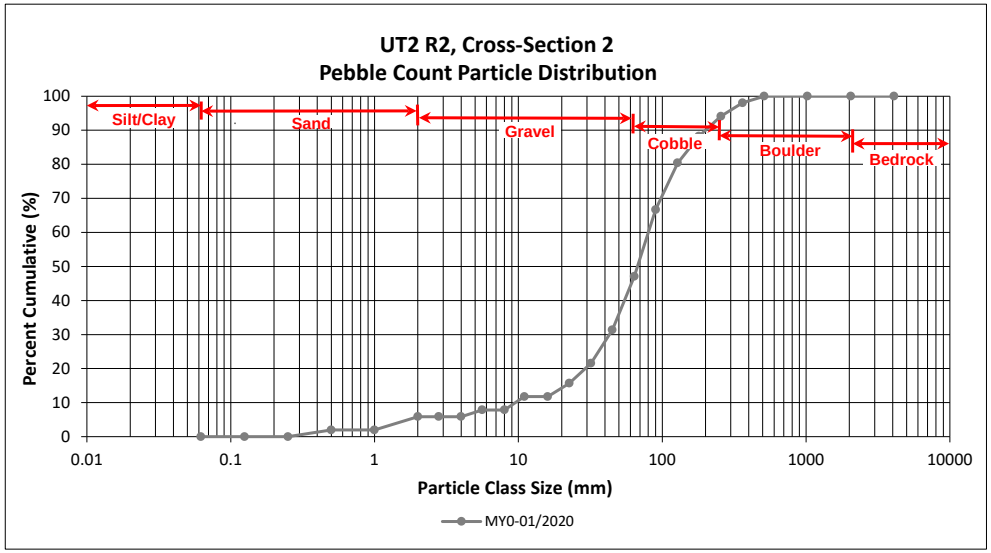
Reachwide and Cross-Section Pebble Count Plots

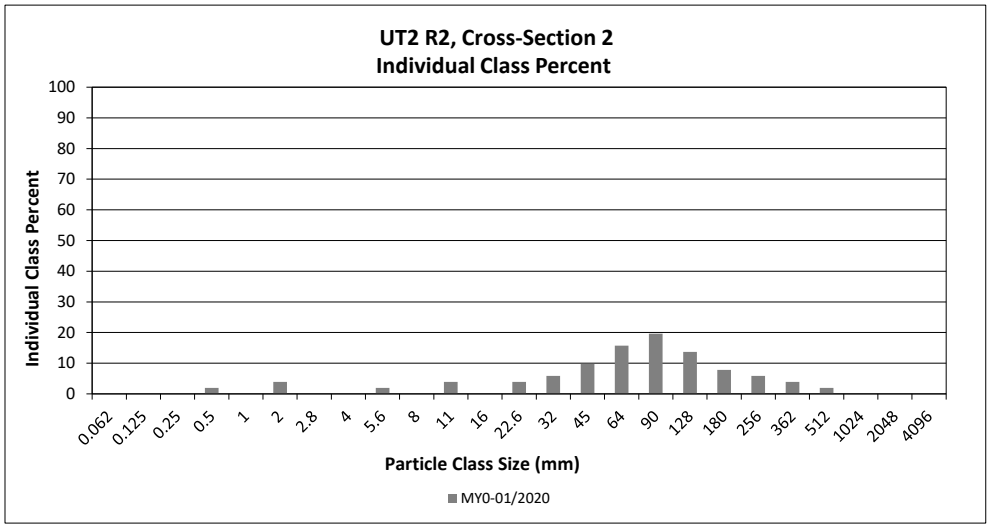
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT2 R2, Cross-Section 2

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50	2	2	2
	Coarse	0.5	1.0			2
	Very Coarse	1.0	2.0	4	4	6
GRAVEL	Very Fine	2.0	2.8			6
	Very Fine	2.8	4.0			6
	Fine	4.0	5.6	2	2	8
	Fine	5.6	8.0			8
	Medium	8.0	11.0	4	4	12
	Medium	11.0	16.0			12
	Coarse	16.0	22.6	4	4	16
	Coarse	22.6	32	6	6	22
	Very Coarse	32	45	10	10	31
	Very Coarse	45	64	16	16	47
COBBLE	Small	64	90	20	20	67
	Small	90	128	14	14	80
	Large	128	180	8	8	88
	Large	180	256	6	6	94
BOULDER	Small	256	362	4	4	98
	Small	362	512	2	2	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**102**	**100**	**100**

Cross-Section 2	
Channel materials (mm)	
D_{16} =	23.0
D_{35} =	48.8
D_{50} =	67.4
D_{84} =	149.7
D_{95} =	276.8
D_{100} =	512.0





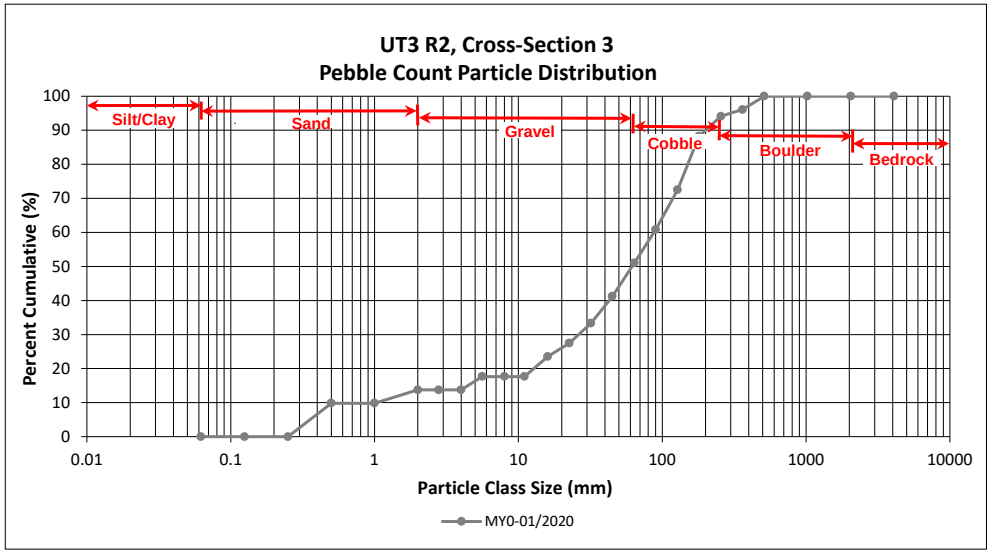
Reachwide and Cross-Section Pebble Count Plots

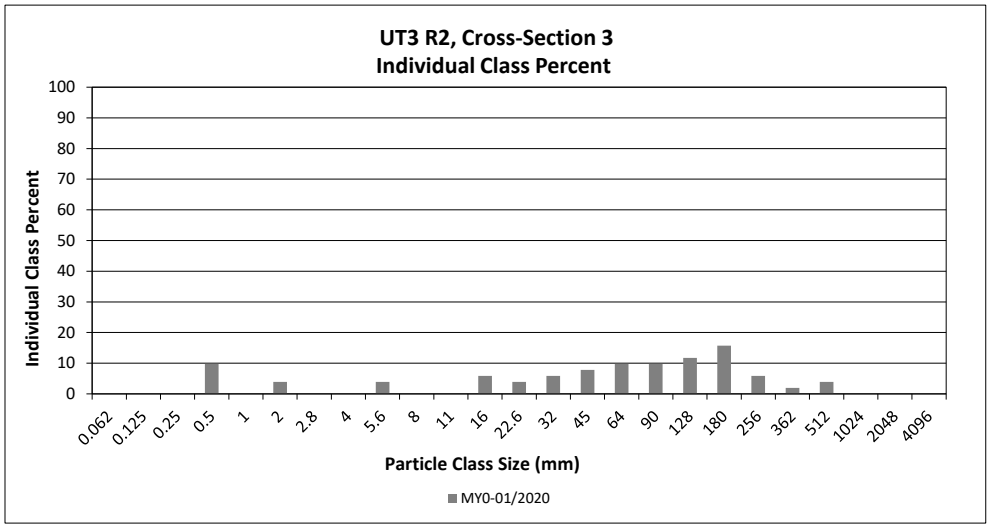
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT3 R2, Cross-Section 3

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50	10	10	10
	Coarse	0.5	1.0			10
	Very Coarse	1.0	2.0	4	4	14
GRAVEL	Very Fine	2.0	2.8			14
	Very Fine	2.8	4.0			14
	Fine	4.0	5.6	4	4	18
	Fine	5.6	8.0			18
	Medium	8.0	11.0			18
	Medium	11.0	16.0	6	6	24
	Coarse	16.0	22.6	4	4	27
	Coarse	22.6	32	6	6	33
	Very Coarse	32	45	8	8	41
	Very Coarse	45	64	10	10	51
COBBLE	Small	64	90	10	10	61
	Small	90	128	12	12	73
	Large	128	180	16	16	88
	Large	180	256	6	6	94
BOULDER	Small	256	362	2	2	96
	Small	362	512	4	4	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**102**	**100**	**100**

Cross-Section 3	
Channel materials (mm)	
D_{16} =	4.9
D_{35} =	34.4
D_{50} =	61.8
D_{84} =	164.2
D_{95} =	299.2
D_{100} =	512.0





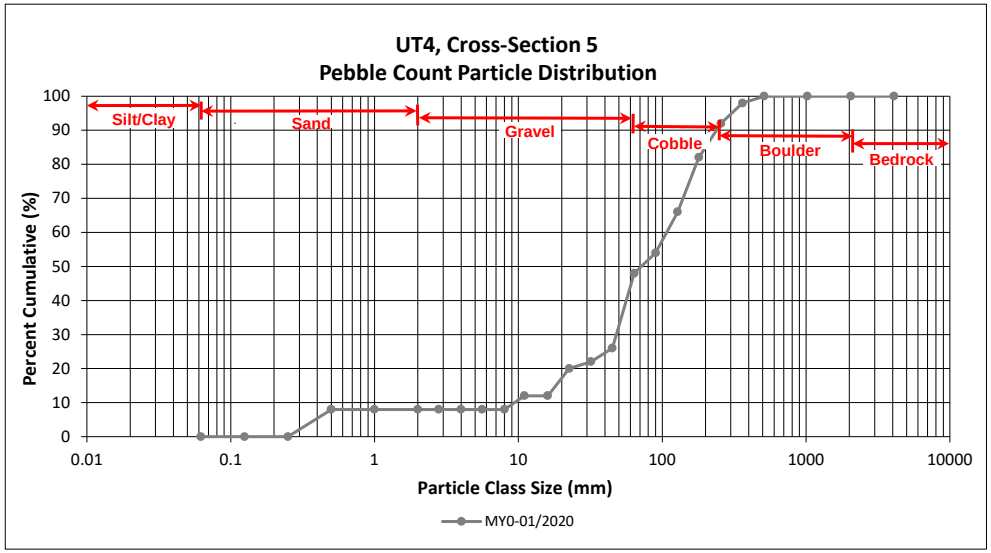
Reachwide and Cross-Section Pebble Count Plots

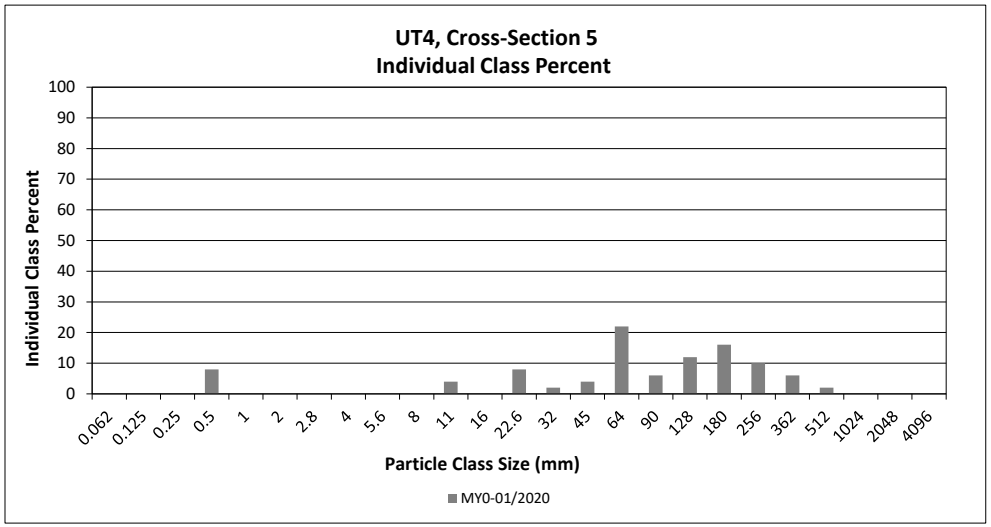
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT4, Cross-Section 5

Particle Class		Diameter (mm) min	Diameter (mm) max	Riffle 100-Count	Summary: Class Percentage	Summary: Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50	8	8	8
	Coarse	0.5	1.0			8
	Very Coarse	1.0	2.0			8
GRAVEL	Very Fine	2.0	2.8			8
	Very Fine	2.8	4.0			8
	Fine	4.0	5.6			8
	Fine	5.6	8.0			8
	Medium	8.0	11.0	4	4	12
	Medium	11.0	16.0			12
	Coarse	16.0	22.6	8	8	20
	Coarse	22.6	32	2	2	22
	Very Coarse	32	45	4	4	26
	Very Coarse	45	64	22	22	48
COBBLE	Small	64	90	6	6	54
	Small	90	128	12	12	66
	Large	128	180	16	16	82
	Large	180	256	10	10	92
BOULDER	Small	256	362	6	6	98
	Small	362	512	2	2	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 5	
Channel materials (mm)	
D_{16} =	19.0
D_{35} =	52.0
D_{50} =	71.7
D_{84} =	193.1
D_{95} =	304.4
D_{100} =	512.0





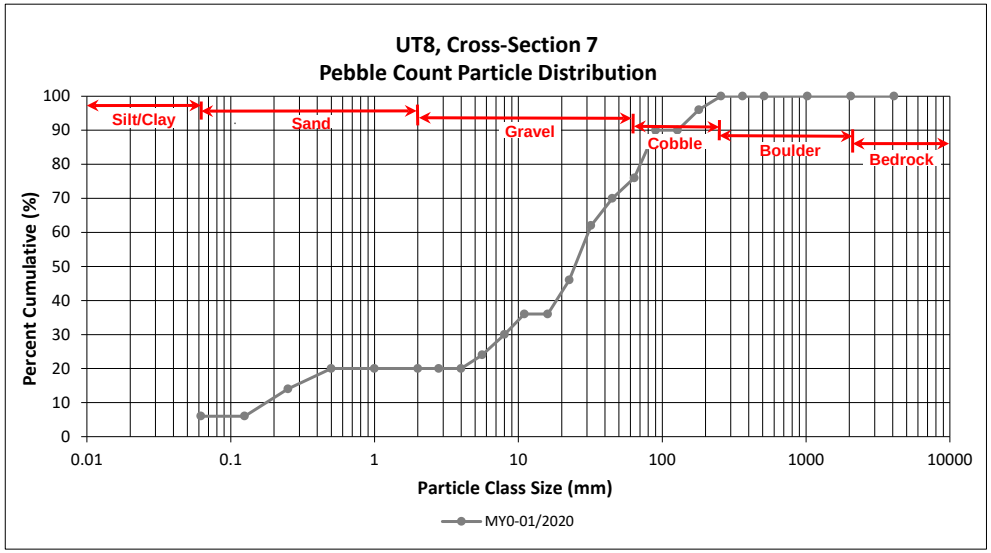
Reachwide and Cross-Section Pebble Count Plots

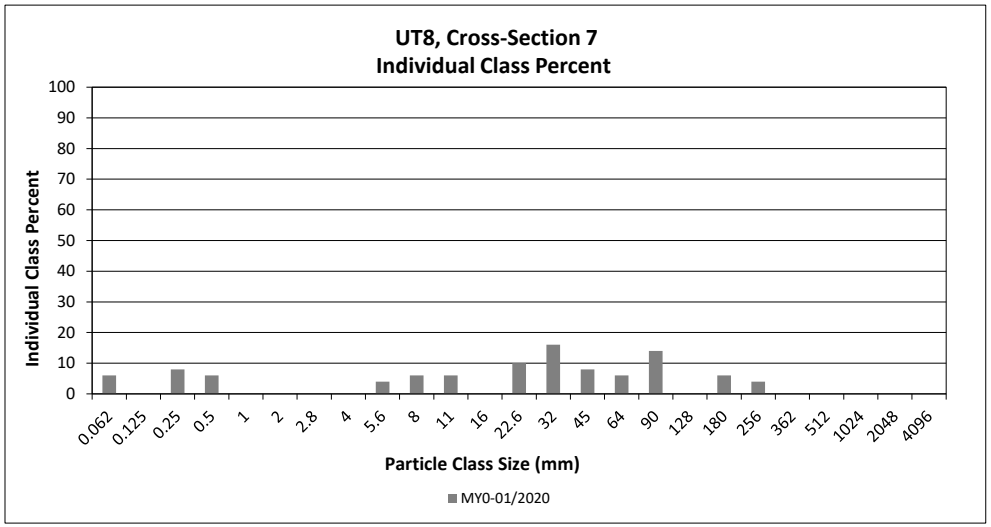
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

UT8, Cross-Section 7

Particle Class		Diameter (mm) min	Diameter (mm) max	Riffle 100-Count	Summary: Class Percentage	Summary: Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	6	6	6
SAND	Very fine	0.062	0.125			6
	Fine	0.125	0.250	8	8	14
	Medium	0.25	0.50	6	6	20
	Coarse	0.5	1.0			20
	Very Coarse	1.0	2.0			20
GRAVEL	Very Fine	2.0	2.8			20
	Very Fine	2.8	4.0			20
	Fine	4.0	5.6	4	4	24
	Fine	5.6	8.0	6	6	30
	Medium	8.0	11.0	6	6	36
	Medium	11.0	16.0			36
	Coarse	16.0	22.6	10	10	46
	Coarse	22.6	32	16	16	62
	Very Coarse	32	45	8	8	70
	Very Coarse	45	64	6	6	76
COBBLE	Small	64	90	14	14	90
	Small	90	128			90
	Large	128	180	6	6	96
	Large	180	256	4	4	100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 7	
Channel materials (mm)	
D_{16} =	0.3
D_{35} =	10.4
D_{50} =	24.7
D_{84} =	77.8
D_{95} =	170.1
D_{100} =	256.0





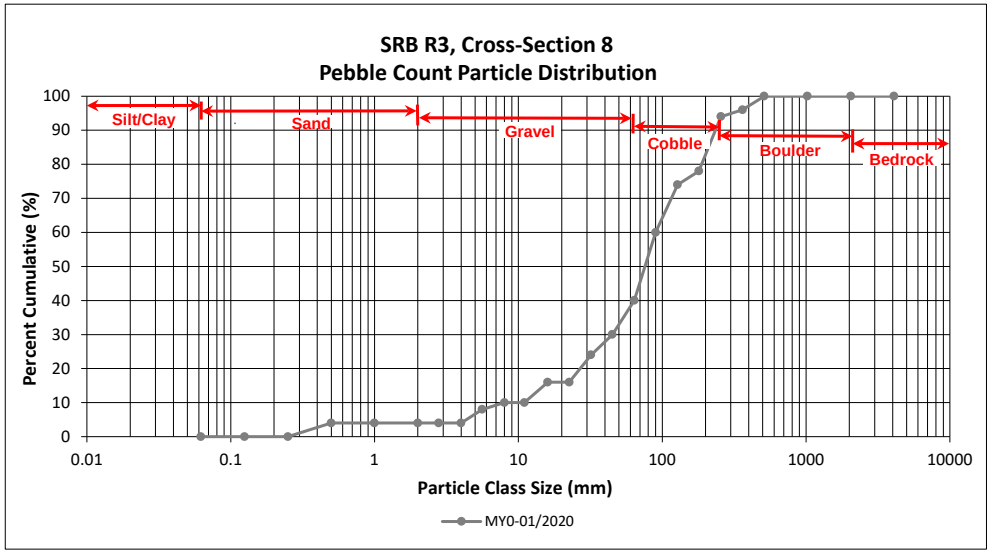
Reachwide and Cross-Section Pebble Count Plots

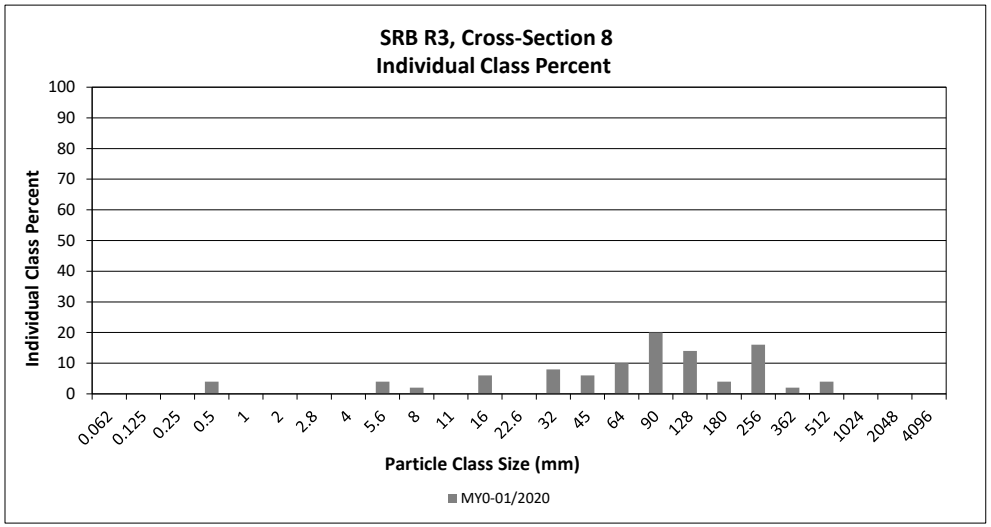
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

SRB R3, Cross-Section 8

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50	4	4	4
	Coarse	0.5	1.0			4
	Very Coarse	1.0	2.0			4
GRAVEL	Very Fine	2.0	2.8			4
	Very Fine	2.8	4.0			4
	Fine	4.0	5.6	4	4	8
	Fine	5.6	8.0	2	2	10
	Medium	8.0	11.0			10
	Medium	11.0	16.0	6	6	16
	Coarse	16.0	22.6			16
	Coarse	22.6	32	8	8	24
	Very Coarse	32	45	6	6	30
	Very Coarse	45	64	10	10	40
COBBLE	Small	64	90	20	20	60
	Small	90	128	14	14	74
	Large	128	180	4	4	78
	Large	180	256	16	16	94
BOULDER	Small	256	362	2	2	96
	Small	362	512	4	4	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 8	
Channel materials (mm)	
D_{16} =	16.0
D_{35} =	53.7
D_{50} =	75.9
D_{84} =	205.4
D_{95} =	304.4
D_{100} =	512.0





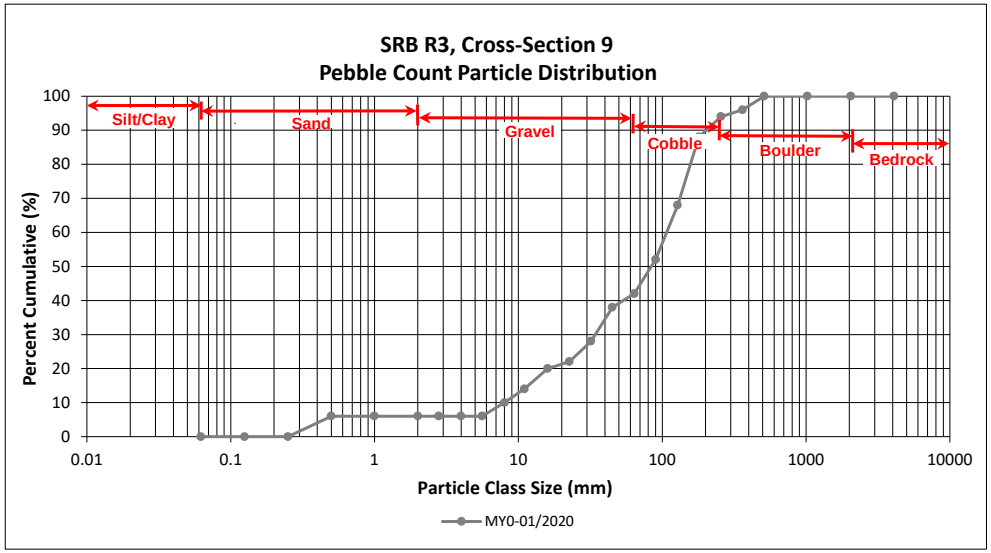
Reachwide and Cross-Section Pebble Count Plots

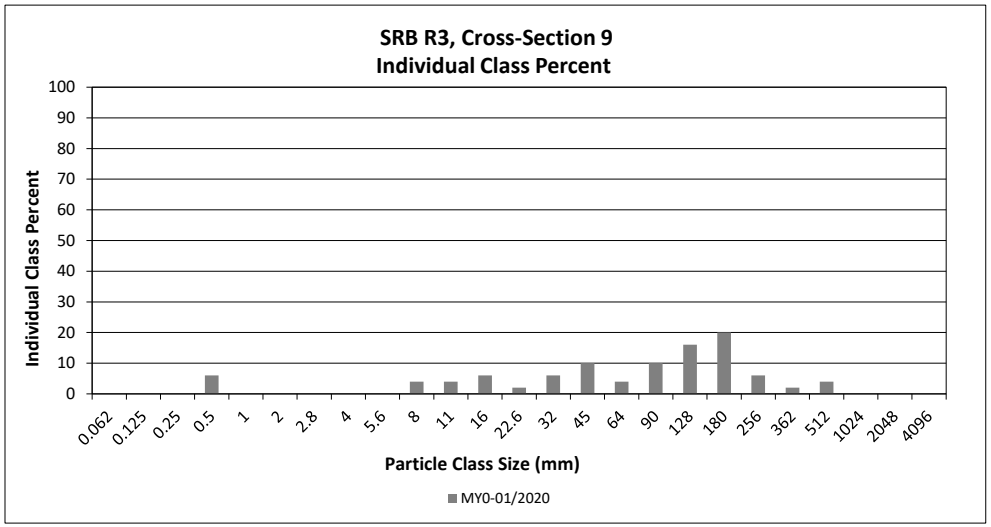
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

SRB R3, Cross-Section 9

Particle Class		Diameter (mm) min	Diameter (mm) max	Riffle 100-Count	Summary: Class Percentage	Summary: Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50	6	6	6
	Coarse	0.5	1.0			6
	Very Coarse	1.0	2.0			6
GRAVEL	Very Fine	2.0	2.8			6
	Very Fine	2.8	4.0			6
	Fine	4.0	5.6			6
	Fine	5.6	8.0	4	4	10
	Medium	8.0	11.0	4	4	14
	Medium	11.0	16.0	6	6	20
	Coarse	16.0	22.6	2	2	22
	Coarse	22.6	32	6	6	28
	Very Coarse	32	45	10	10	38
	Very Coarse	45	64	4	4	42
COBBLE	Small	64	90	10	10	52
	Small	90	128	16	16	68
	Large	128	180	20	20	88
	Large	180	256	6	6	94
BOULDER	Small	256	362	2	2	96
	Small	362	512	4	4	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 9	
Channel materials (mm)	
D_{16} =	12.5
D_{35} =	40.6
D_{50} =	84.1
D_{84} =	168.1
D_{95} =	304.4
D_{100} =	512.0





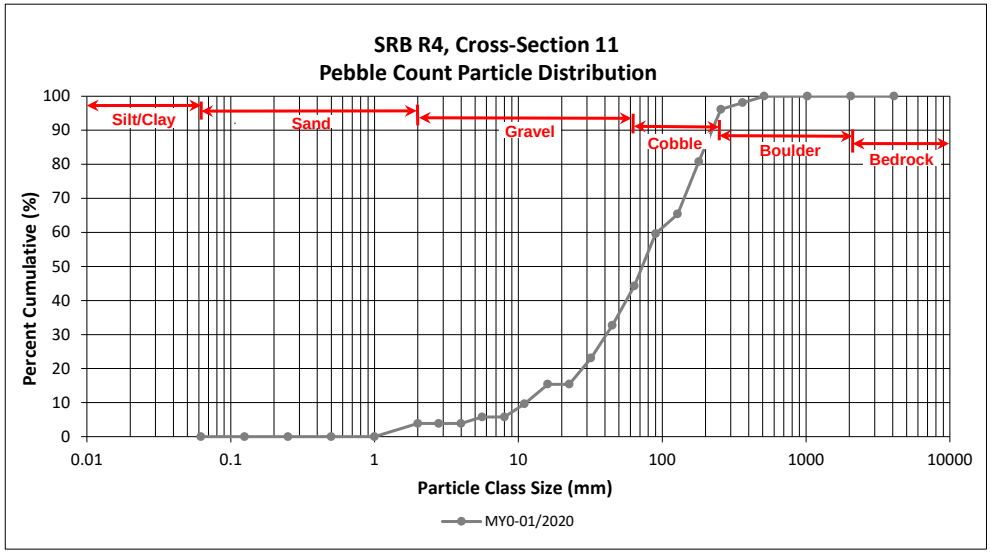
Reachwide and Cross-Section Pebble Count Plots

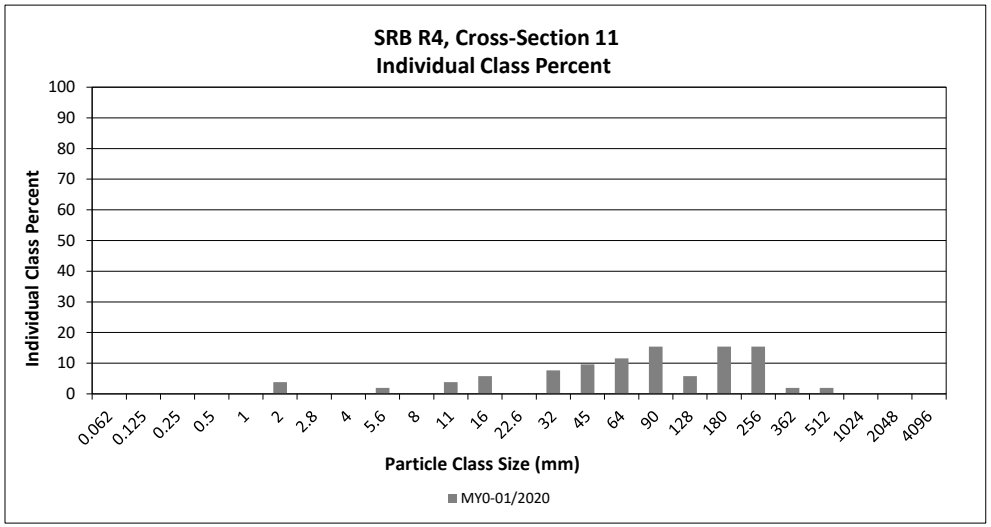
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

SRB R4, Cross-Section 11

Particle Class		Diameter (mm) min	Diameter (mm) max	Riffle 100-Count	Summary: Class Percentage	Summary: Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50			0
	Coarse	0.5	1.0			0
	Very Coarse	1.0	2.0	4	4	4
GRAVEL	Very Fine	2.0	2.8			4
	Very Fine	2.8	4.0			4
	Fine	4.0	5.6	2	2	6
	Fine	5.6	8.0			6
	Medium	8.0	11.0	4	4	10
	Medium	11.0	16.0	6	6	15
	Coarse	16.0	22.6			15
	Coarse	22.6	32	8	8	23
	Very Coarse	32	45	10	10	33
	Very Coarse	45	64	12	12	44
COBBLE	Small	64	90	16	15	60
	Small	90	128	6	6	65
	Large	128	180	16	15	81
	Large	180	256	16	15	96
BOULDER	Small	256	362	2	2	98
	Small	362	512	2	2	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**104**	**100**	**100**

Cross-Section 11	
Channel materials (mm)	
D_{16} =	23.2
D_{35} =	48.3
D_{50} =	72.7
D_{84} =	193.8
D_{95} =	249.3
D_{100} =	512.0





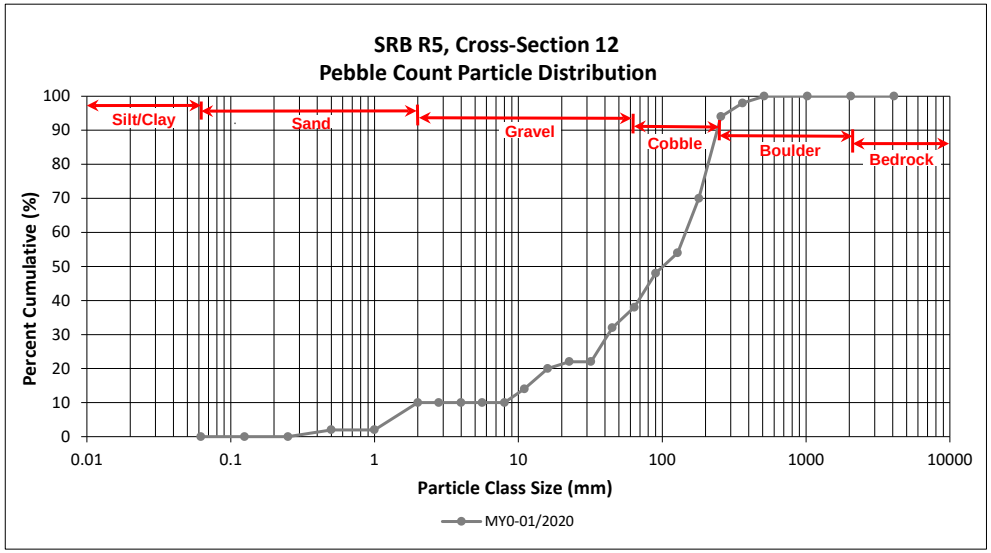
Reachwide and Cross-Section Pebble Count Plots

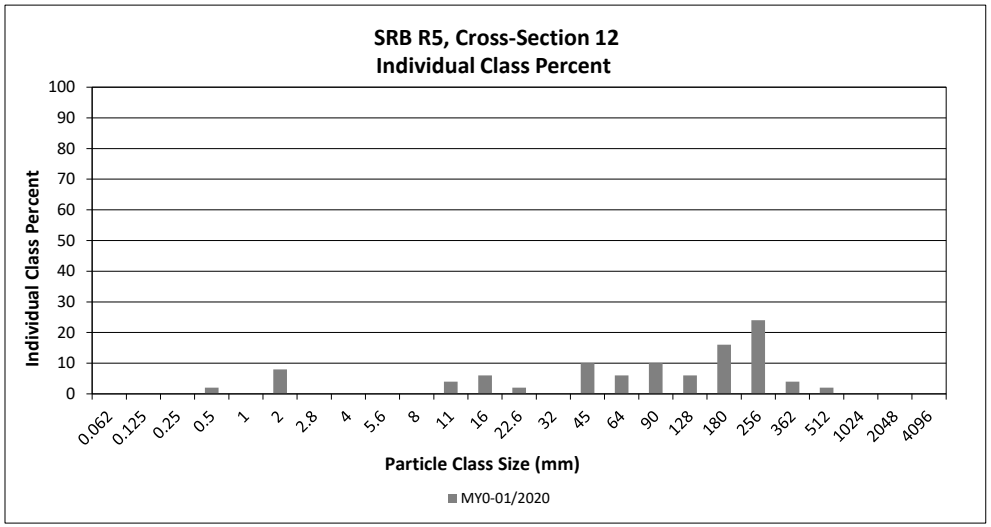
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

SRB R5, Cross-Section 12

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50	2	2	2
	Coarse	0.5	1.0			2
	Very Coarse	1.0	2.0	8	8	10
GRAVEL	Very Fine	2.0	2.8			10
	Very Fine	2.8	4.0			10
	Fine	4.0	5.6			10
	Fine	5.6	8.0			10
	Medium	8.0	11.0	4	4	14
	Medium	11.0	16.0	6	6	20
	Coarse	16.0	22.6	2	2	22
	Coarse	22.6	32			22
	Very Coarse	32	45	10	10	32
	Very Coarse	45	64	6	6	38
COBBLE	Small	64	90	10	10	48
	Small	90	128	6	6	54
	Large	128	180	16	16	70
	Large	180	256	24	24	94
BOULDER	Small	256	362	4	4	98
	Small	362	512	2	2	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 12	
Channel materials (mm)	
D_{16} =	12.5
D_{35} =	53.7
D_{50} =	101.2
D_{84} =	221.1
D_{95} =	279.2
D_{100} =	512.0





Stream Photographs

	
Photo Point 1 – UT1 Reach 1, view upstream *(01/20/2020)*	**Photo Point 1** – UT1 Reach 1, view downstream *(01/20/2020)*
	
Photo Point 2 – UT1 Reach 1, view upstream *(01/20/2020)*	**Photo Point 2** – UT1 Reach 1, view downstream *(01/20/2020)*
	
Photo Point 3 – UT1A, view upstream *(01/20/2020)*	**Photo Point 3** – UT1A, view downstream *(01/20/2020)*

Photo Point 4 – UT1 Reach 2, view upstream *(01/20/2020)*

Photo Point 4 – UT1 Reach 2, view downstream *(01/20/2020)*

Photo Point 5 – UT2 Reach 1, view upstream *(01/20/2020)*

Photo Point 5 – UT1 Reach 1, view downstream *(01/20/2020)*

Photo Point 6 – UT2 Reach 2, view upstream *(01/20/2020)*

Photo Point 6 – UT2 Reach 2, view downstream *(01/20/2020)*

	
Photo Point 7 – UT3 Reach 1, view upstream *(01/20/2020)*	**Photo Point 7** – UT3 Reach 1, view downstream *(01/20/2020)*
	
Photo Point 8 – UT3 Reach 2, view upstream *(01/20/2020)*	**Photo Point 8** – UT3 Reach 2, view downstream *(01/20/2020)*
	
Photo Point 9 – UT3 Reach 2, view upstream *(01/20/2020)*	**Photo Point 9** – UT3 Reach 2, view downstream *(01/20/2020)*

	
Photo Point 10 – UT3 Reach 2, view upstream *(01/20/2020)*	**Photo Point 10** – UT3 Reach 2, view downstream *(01/20/2020)*
	
Photo Point 11 – UT4, view upstream *(01/20/2020)*	**Photo Point 11** – UT4, view downstream *(01/20/2020)*
	
Photo Point 12 – UT4, view upstream *(01/20/2020)*	**Photo Point 12** – UT4, view downstream *(01/20/2020)*

	
Photo Point 13 – UT4, view upstream *(01/20/2020)*	**Photo Point 13** – UT4, view downstream *(01/20/2020)*
	
Photo Point 14 – UT8, view upstream *(01/20/2020)*	**Photo Point 14** – UT8, view downstream *(01/20/2020)*
	
Photo Point 15 – UT7, view upstream *(01/28/2020)*	**Photo Point 15** – UT7, view downstream *(01/28/2020)*

Photo Point 16 – SRB Reach 1, view upstream *(01/28/2020)*

Photo Point 16 – SRB Reach 1, view downstream *(01/28/2020)*

Photo Point 17 – SRB Reach 2, view upstream *(01/28/2020)*

Photo Point 17 – SRB Reach 2, view downstream *(01/28/2020)*

Photo Point 18 – SRB Reach 3, view upstream *(01/28/2020)*

Photo Point 18 – SRB Reach 3, view downstream *(01/28/2020)*

	
Photo Point 19 – SRB Reach 3, view upstream *(01/28/2020)*	**Photo Point 19** – SRB Reach 3, view downstream *(01/28/2020)*
	
Photo Point 20 – SRB Reach 3, view upstream *(01/28/2020)*	**Photo Point 20** – SRB Reach 3, view downstream *(01/28/2020)*
	
Photo Point 21 – SRB Reach 3, view upstream *(01/28/2020)*	**Photo Point 21** – SRB Reach 3, view downstream *(01/28/2020)*

Photo Point 22 – SRB Reach 3, view upstream *(01/28/2020)*

Photo Point 22 – UT3 Reach 2, view upstream *(01/28/2020)*

Photo Point 22 – SRB Reach 3, view downstream *(01/28/2020)*

Photo Point 23 – SRB Reach 4, view upstream *(01/28/2020)*

Photo Point 23 – SRB Reach 4, view downstream *(01/28/2020)*

Photo Point 24 – SRB Reach 4, view upstream *(01/28/2020)*

Photo Point 24 – SRB Reach 5, view downstream *(01/28/2020)*

Photo Point 25 – SRB Reach 5, view upstream *(01/28/2020)*

Photo Point 25 – SRB Reach 5, view downstream *(01/28/2020)*

Photo Point 26 – SRB Reach 5, view upstream *(01/28/2020)*

Photo Point 26 – SRB Reach 5, view downstream *(01/28/2020)*

	
Photo Point 27 – SRB Reach 5, view upstream *(01/28/2020)*	**Photo Point 27** – SRB Reach 5, view downstream *(01/28/2020)*
	
Photo Point 28 – UT6, view upstream *(01/28/2020)*	**Photo Point 28** – UT6, view downstream *(01/28/2020)*
	
Photo Point 29 – UT6, view upstream *(01/28/2020)*	**Photo Point 29** – UT6, view downstream *(01/28/2020)*

	
Photo Point 30 – UT5, view upstream *(01/28/2020)*	**Photo Point 30** – UT5, view downstream *(01/28/2020)*

APPENDIX 3. Vegetation Plot Data

Table 9. Planted and Total Stem Counts
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Current Permanent Vegetation Plot Data (MY0 2020)																	Annual Mean		
Scientific Name	**Common Name**	**Species Type**	**Permanent Plot 1**			**Permanent Plot 2**			**Permanent Plot 3**			**Permanent Plot 4**			**Permanent Plot 5**			**MY0 (2020)**		
			PnoLS	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Betula nigra	River Birch	Tree	1	1	1	3	3	3	2	2	2	3	3	3	3	3	3	12	12	12
Diospyros virginiana	American Persimmon	Tree	2	2	2				1	1	1							3	3	3
Fagus grandifolia	American Beech	Tree	2	2	2							1	1	1				3	3	3
Fraxinus pennsylvanica	Green Ash	Tree				1	1	1	3	3	3	3	3	3				7	7	7
Liriodendron tulipifera	Tulip Poplar	Tree	1	1	1	4	4	4	3	3	3	2	2	2	2	2	2	12	12	12
Nyssa sylvatica	Black Gum	Tree				2	2	2	2	2	2	1	1	1	3	3	3	8	8	8
Platanus occidentalis	Sycamore	Tree	3	3	3	1	1	1	2	2	2	2	2	2	2	2	2	10	10	10
Quercus alba	White Oak	Tree	3	3	3										1	1	1	4	4	4
Quercus falcata	Southern Red Oak	Tree													1	1	1	1	1	1
Quercus rubra	Red Oak	Tree	3	3	3	4	4	4	2	2	2	3	3	3	3	3	3	15	15	15
		Stem count	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	75	75	75
		size (ares)	1			1			1			1			1			5		
		size (ACRES)	0.0247			0.0247			0.0247			0.0247			0.0247			0.124		
		Species count	7	7	7	6	6	6	7	7	7	7	7	7	7	7	7	10	10	10
		Stems per ACRE	607	607	607	607	607	607	607	607	607	607	607	607	607	607	607	607	607	607

Current Mobile Vegetation Plot Data (MY0 2020)							Annual Mean	Overall Mean
Scientific Name	**Common Name**	**Species Type**	**Mobile Plot 1**	**Mobile Plot 2**	**Mobile Plot 3**	**Mobile Plot 4**	**MY0 (2020)**	**MY0 (2020)**
			PnoLS	**PnoLS**	**PnoLS**	**PnoLS**	**PnoLS**	**PnoLS**
Betula nigra	River Birch	Tree	2	1	1	2	6	18
Diospyros virginiana	American Persimmon	Tree						3
Fagus grandifolia	American Beech	Tree	1		1	1	3	6
Fraxinus pennsylvanica	Green Ash	Tree			1		1	8
Liriodendron tulipifera	Tulip Poplar	Tree		3	2	2	7	19
Nyssa sylvatica	Black Gum	Tree	1	3	1	3	8	16
Platanus occidentalis	Sycamore	Tree	2	5	1	1	9	19
Quercus alba	White Oak	Tree	1		1	1	3	7
Quercus falcata	Southern Red Oak	Tree						1
Quercus rubra	Red Oak	Tree	8	4	1	4	17	32
		Stem count	15	16	9	14	54	129
		size (ares)	1	1	1	1	4	9
		size (ACRES)	0.0247	0.0247	0.0247	0.0247	0.099	0.222
		Species count	6	5	8	7	8	10
		Stems per ACRE	607	647	364	567	546	580

Color for Density

Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%
Volunteer species included in total

PnoLS: Number of planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total stems

Vegetation Plot Photographs

Permanent Vegetation Plot 1 – *(1/06/2020)*

Permanent Vegetation Plot 2 – *(1/06/2020)*

Permanent Vegetation Plot 3 – *(1/06/2020)*

Permanent Vegetation Plot 4 – *(1/06/2020)*

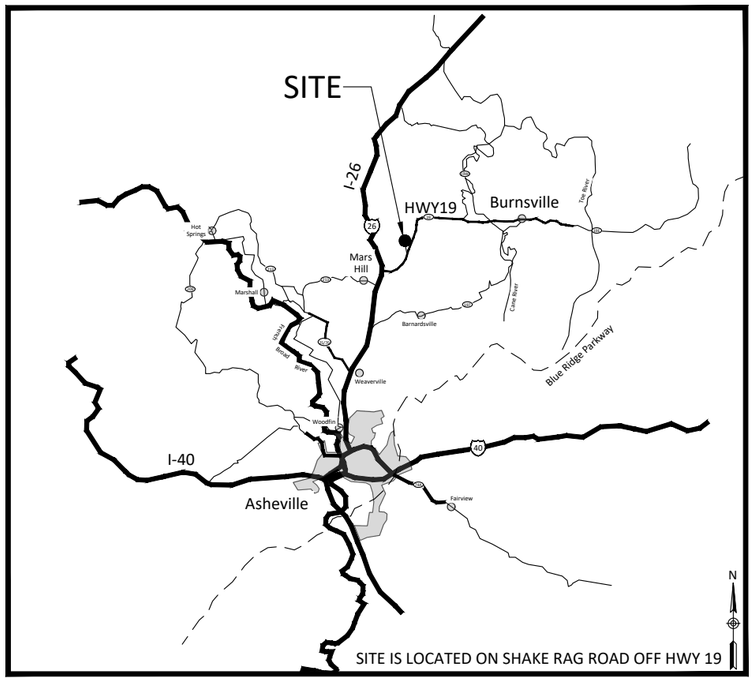
Permanent Vegetation Plot 5 – *(1/06/2020)*

	
Mobile Vegetation Plot 1 – *(4/02/2020)*	**Mobile Vegetation Plot 2** – *(4/02/2020)*
	
Mobile Vegetation Plot 3 – *(4/02/2020)*	**Mobile Vegetation Plot 4** – *(4/02/2020)*

APPENDIX 4. Record Drawings

April 23, 2020

Shake Rag Branch Mitigation Site
Record Drawings
Madison County, North Carolina
for
NCDEQ
Division of Mitigation Services



Vicinity Map
Not to Scale

BEFORE YOU DIG!
CALL 1-800-632-4949
N.C. ONE-CALL CENTER
IT'S THE LAW!

RECORD DRAWINGS
ISSUED April 3, 2020

CERTIFICATE OF SURVEY AND ACCURACY

I, DREW VAN DUINKERKEN , CERTIFY THAT THE GROUND TOPOGRAPHIC SURVEY PORTION OF THIS PROJECT WAS COMPLETED UNDER MY DIRECT SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY DIRECT SUPERVISION; THAT THE RECORD DRAWINGS WERE PREPARED BY WILDLANDS ENGINEERING, INC. FROM DIGITAL FILES PROVIDED BY KEE MAPPING AND SURVEYING, PA AS SHOWN ON AN AS-BUILT SURVEY FOR "WILDLANDS ENGINEERING, INC., SHAKE RAG BRANCH MITIGATION SITE", JOB #: 190881-AB, DATED: APRIL 23, 2020; THAT THIS SURVEY WAS PERFORMED AT THE 95% CONFIDENCE LEVEL TO MEET THE FEDERAL GEOGRAPHIC DATA COMMITTEE STANDARDS AND TO MEET THE REQUIREMENTS OF A TOPOGRAPHIC SURVEY TO THE ACCURACY OF CLASS _A_ HORIZONTAL AND CLASS _C_ VERTICAL WHERE APPLICABLE; THAT THE ORIGINAL DATA WAS OBTAIN BETWEEN THE DATES OF 12/19/19 - 04/01/20 ; THAT THE CONTOURS SHOWN AS BROKEN LINES MAY NOT MEET THE STATED STANDARD; THAT ALL COORDINATES ARE BASED ON NAD 83 (NSRS 2011) AND ALL ELEVATIONS ARE BASED ON NAVD 88; THAT THIS SURVEY MEETS THE SPECIFICATIONS FOR TOPOGRAPHIC SURVEYS AS STATED IN TITLE 21, CHAPTER 56, SECTION .1606; THAT THIS SURVEY WAS NOT PREPARED IN ACCORDANCE WITH G.S. 47-30, AS AMENDED AND DOES NOT REPRESENT AN OFFICIAL BOUNDARY SURVEY.

WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 24TH DAY OF APRIL , 2020.

NORTH CAROLINA PROFESSIONAL SEAL L-5010 LAND SURVEYOR DREW VAN DUINKERKEN

DocuSigned by:
Drew V. Duinkerken
56DF6592ABFF4B8...
DREW VAN DUINKERKEN, PLS L-5010

Sheet Index

Project Directory

Engineering:
Wildlands Engineering, Inc
License No. F-0831
167-B Haywood Road
Asheville, NC 28806
Jake Mclean, PE
828-774-5547

As-Build Survey:
Kee Mapping and Surveying
P.O. Box 2566
Asheville, NC 28802
Drew Van Duinkerken, PLS
828-575-9021

Owner:
NCDEQ
Division of Mitigation Services
5 Ravenscroft Drive, Ste 102
Asheville, NC 28801
Matthew Reid
828-273-1673

DMS Project No. 100018
Contract No. 7190
French Broad River Basin
HUC 06010105

WILDLANDS ENGINEERING
167-B Haywood Road
Asheville, NC 28806
Tel: 828.774.5547
Fax: 704.332.3305
Firm License No. F-0831

NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina
Title Sheet

Revisions:

Date: April 23, 2020
Job Number: 055-02164
Project Engineer: JM
Drawn By: JPH
Checked By: JK

Sheet 0.1

As-Built Features

- As-Built Bankfull
- As-Built Major Contour (100)
- As-Built Minor Contour
- As-Built Cross Section
- As-Built Overhead electric (OW)
- As-Built Fence
- As-Built Farm Road
- As-Built Vegetation Monitoring Plot (VP#, VEG)
- Crest Gage (CG#)
- Stream Gage (SG#)
- Barotroll (BT#)
- Photo Point (PP#)

As-Built Structures

- As-Built Brush Toe
- As-Built Riffle/Cascading Riffle
- As-Built BMP
- As-Built Headwall
- As-Built Crossing Armoring (Overtopping Flows)

As-Built Structures

- As-Built Lunker Log
- As-Built Rock Drop
- As-Built Rock Drop with Vegetated Stone Toe Protection
- As-Built Culvert

NOTE:

Deviations shown in red.

Pre-construction Features

- Recorded Conservation Easement (CE)
- Recorded Internal Easement (Farm Crossing) (CE-IX)
- Pre-construction Fence
- Pre-construction Property Boundary
- Pre-construction Thalweg
- Pre-construction Wetlands
- Pre-construction Tree
- Pre-construction Bedrock
- Pre-construction Spring

Design Features

- Design Stream Alignment (10+00)
- Design Grading Contour 5' Major
- Design Grading Contour 1' Major
- Design Bankfull

Design Structures

- Design Brush Toe
- Design Lunker Log
- Design Vegetated Stone Toe Protection
- Design Rock Drop
- Design Cascading Riffle
- Design Cascading Riffle-Pool Sequence

PROJECT NOTES:

Topographic survey was completed by Kee Mapping and Surveying in December 2017.

Parcel boundary survey completed by Kee Mapping and Surveying in February 2018.

As-Built survey was performed by Kee Mapping and Surveying, PA for Wildlands Engineering, Inc. between the dates of 12/19/19 – 04/01/20 under the supervision of Drew Van Duinkerken, PLS L-5010; Job #180881-AB; dated 04/23/20. Digital data was supplied to Wildlands Engineering, Inc. for inclusion on the record drawings. As-built data shown on these drawings should be verified with the signed and sealed sheet set prepared by Kee Mapping and Surveying, PA for the Shake Rag Branch Mitigation Site

WILDLANDS ENGINEERING
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Firm License No. F-0831

NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

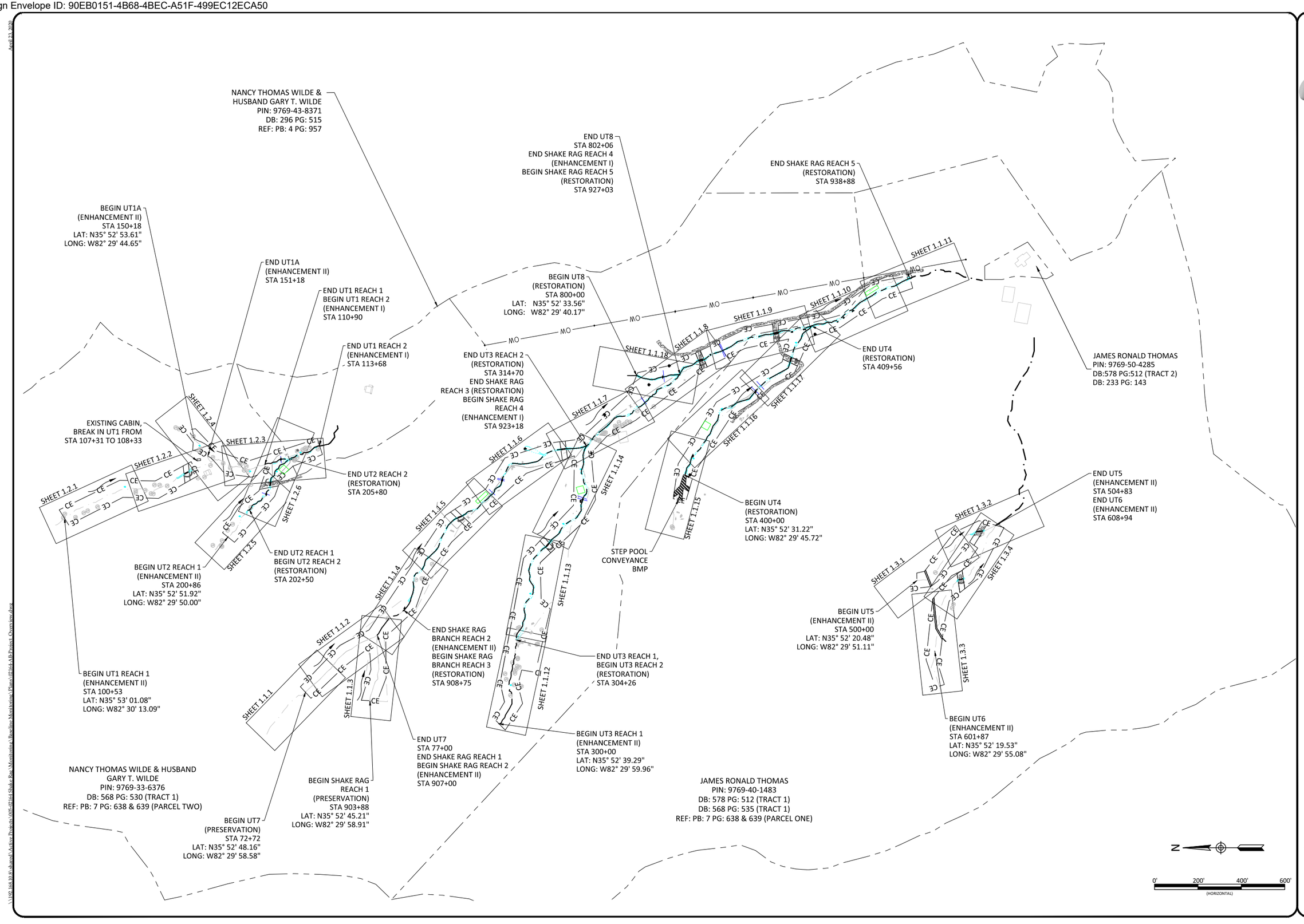
Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

General Notes and Symbols

Revisions:

Date: April 23, 2020
Job Number: 055-02164
Project Engineer: JM
Drawn By: JTH
Checked By: JK

Sheet 0.2



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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

Project Overview

Revisions:

Date:	April 23, 2020
Job Number:	055-02164
Project Engineer:	JM
Drawn By:	JTH
Checked By:	JK

Sheet 0.3

\\192.168.10.8\Shared\Active Projects\055-02164 Shake Rag Monitoring\Baseline Monitoring\Plans\02164 ABP Project Overview.dwg

April 23, 2020

Sheet Index

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

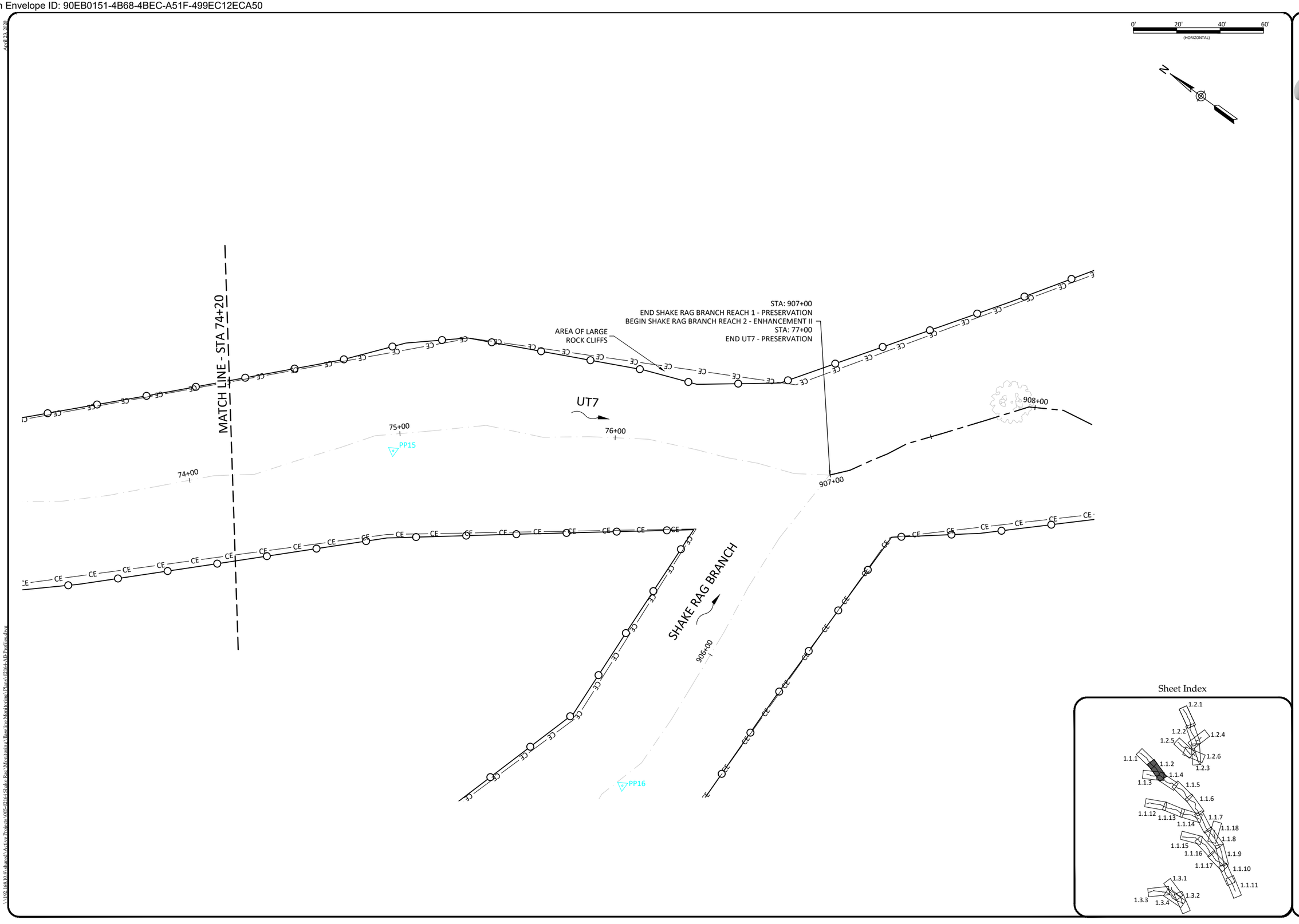
Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

UT7 Preservation
Stream Plan and Profile

Revisions:

Date: April 23, 2020
Job Number: 055-02164
Project Engineer: JM
Drawn By: JTH
Checked By: JK

Sheet 1.1.1



Sheet Index

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

UT7 Preservation
Stream Plan and Profile

Revisions:

Date:	April 23, 2020
Job Number:	055-02164
Project Engineer:	JM
Drawn By:	JTH
Checked By:	JK

Sheet 1.1.2

0' 20' 40' 60'
(HORIZONTAL)

N

UT7

76+00

AREA OF LARGE ROCK CLIFFS

STA: 907+00
END SHAKE RAG BRANCH REACH 1 - PRESERVATION
BEGIN SHAKE RAG BRANCH REACH 2 - ENHANCEMENT II
STA: 77+00
END UT7 - PRESERVATION

SHAKE RAG BRANCH

904+00

905+00

906+00

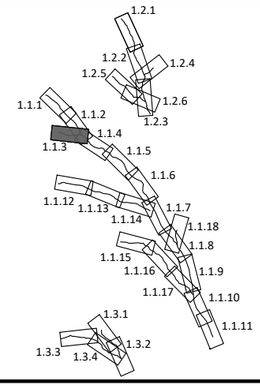
907+00

PP16

STA: 903+88
BEGIN SHAKE RAG BRANCH
REACH 1 - PRESERVATION

MATCH LINE - STA 907+10

Sheet Index



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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

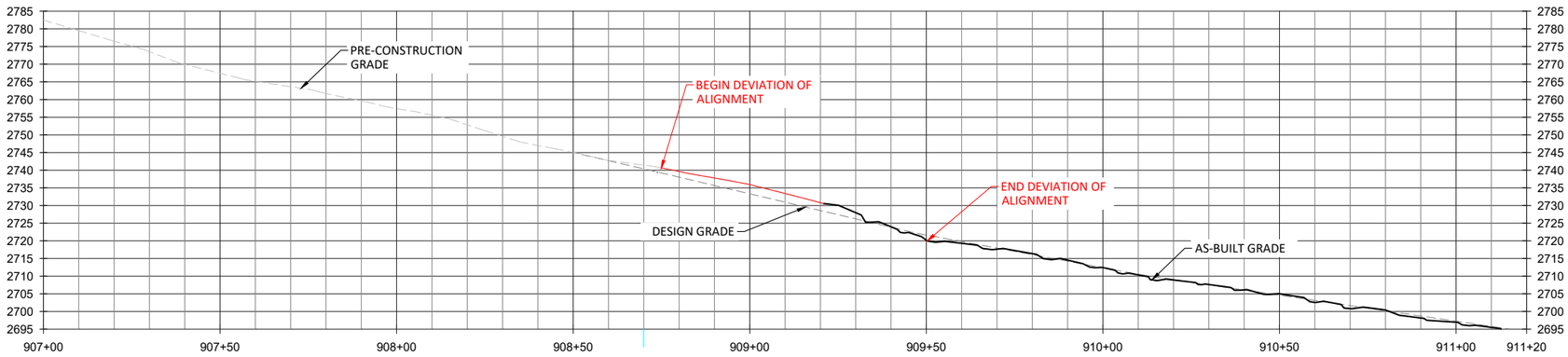
Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

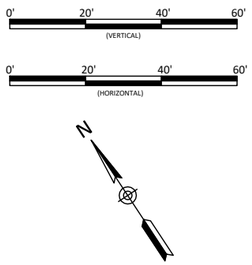
Shake Rag Preservation
Stream Plan and Profile

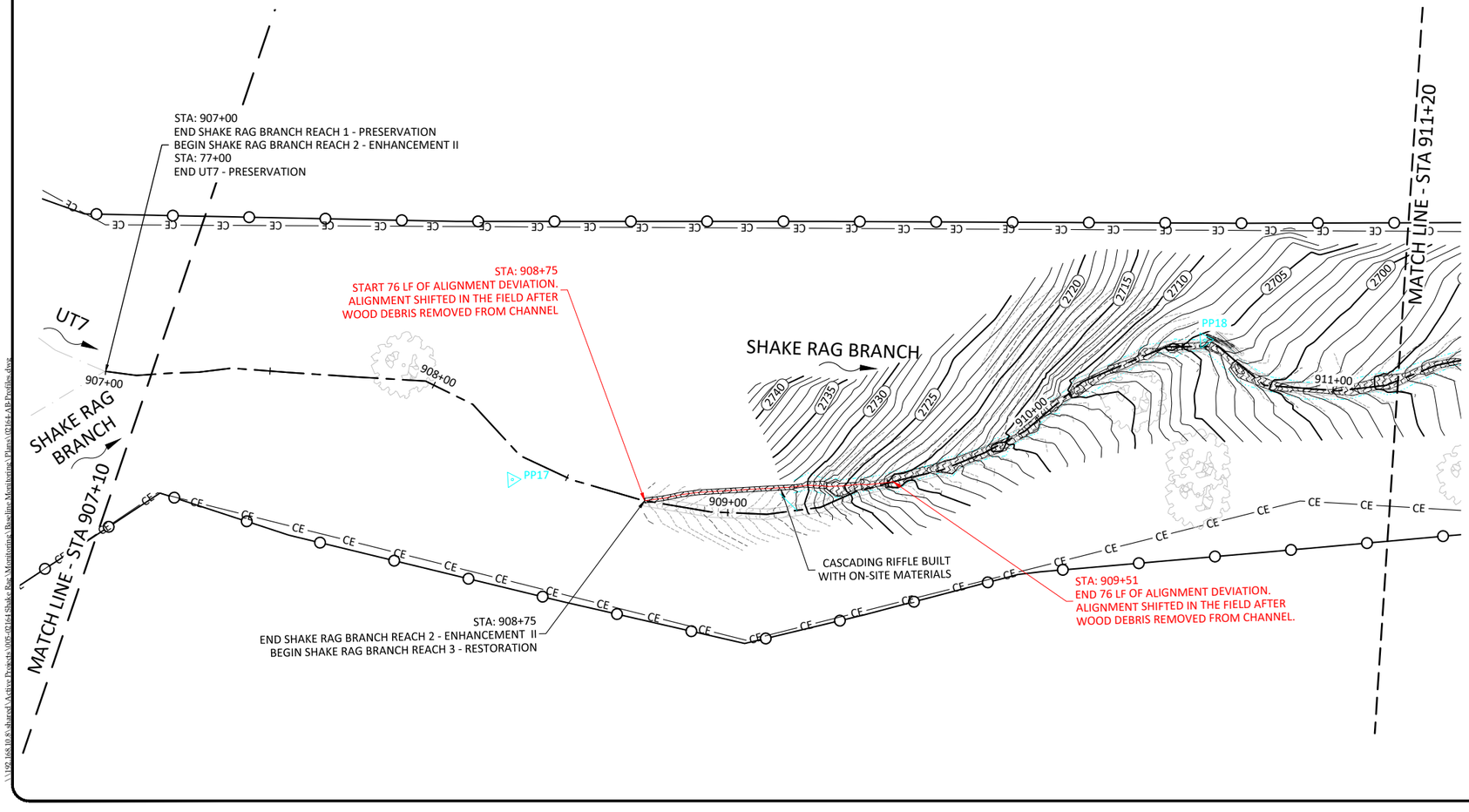
Revisions:

Date: April 23, 2020
Job Number: 055-02164
Project Engineer: JM
Drawn By: JTH
Checked By: JK

Sheet 1.1.3







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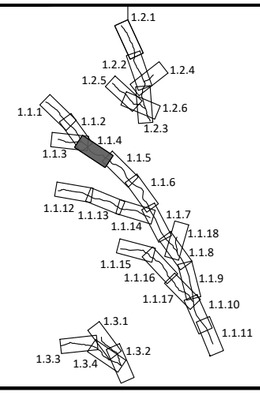

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

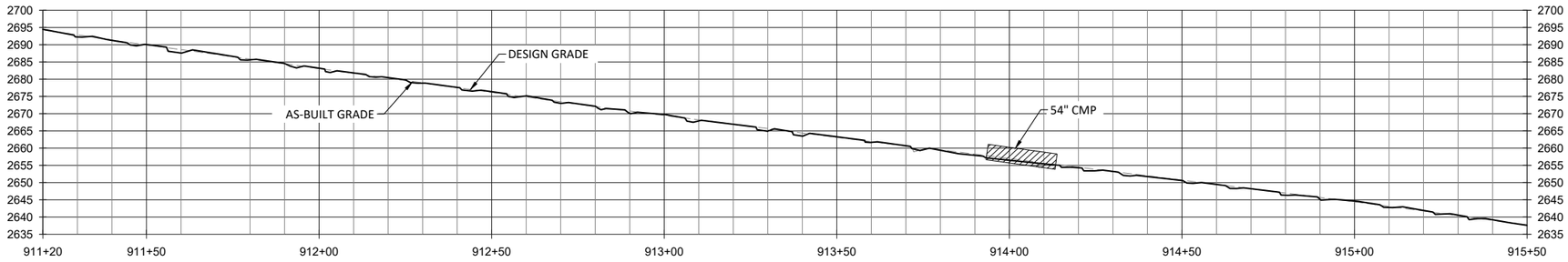
Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

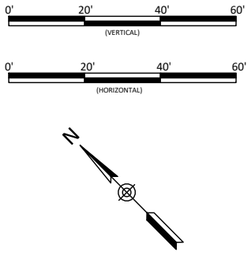
Shake Rag Branch
Stream Plan and Profile

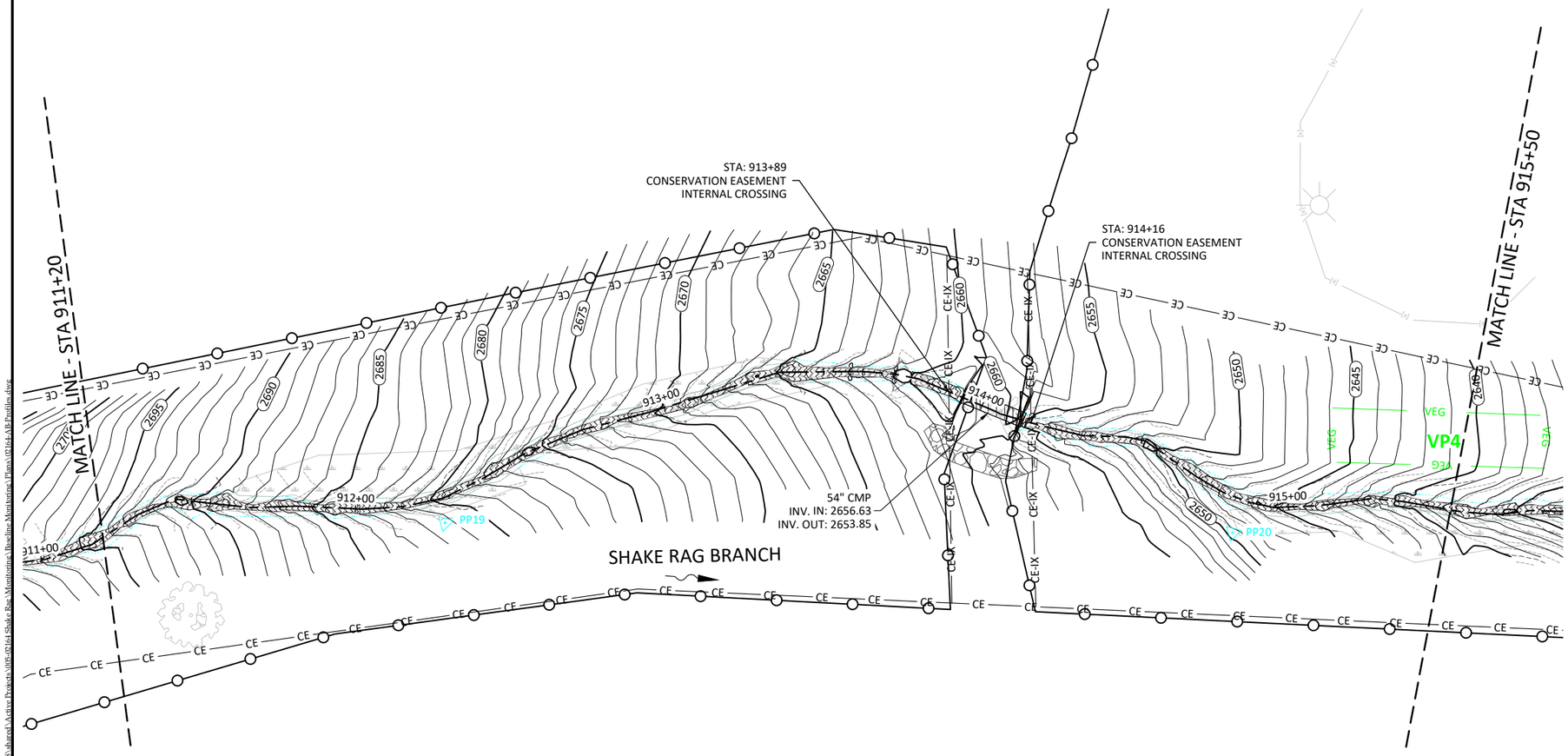
Revisions:

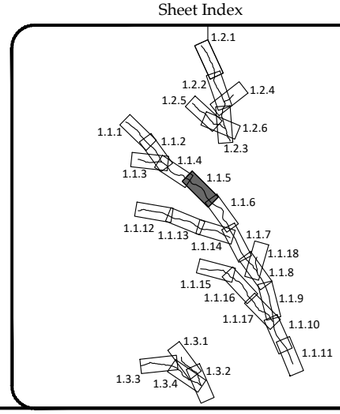
Date:	April 23, 2020
Job Number:	055-02164
Project Engineer:	JM
Drawn By:	JTH
Checked By:	JK

Sheet 1.1.4









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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

Shake Rag Branch
Stream Plan and Profile

Revisions:

Date:	April 23, 2020
Job Number:	055-02164
Project Engineer:	JM
Drawn By:	JTH
Checked By:	JK

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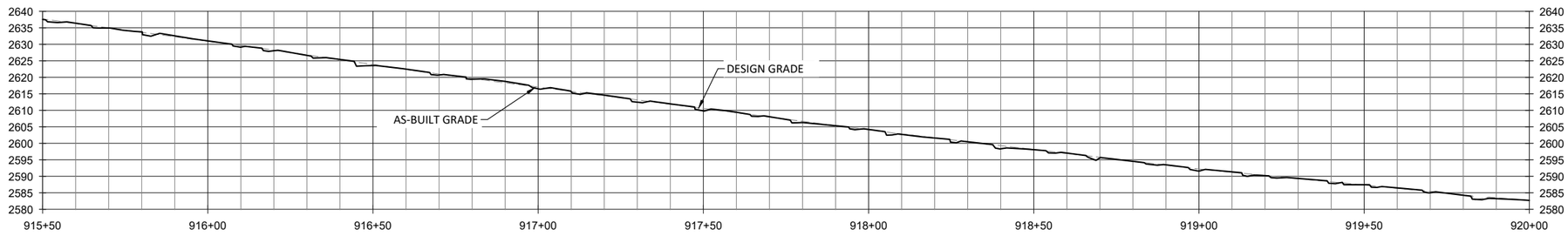

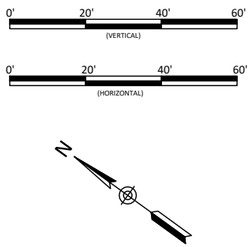

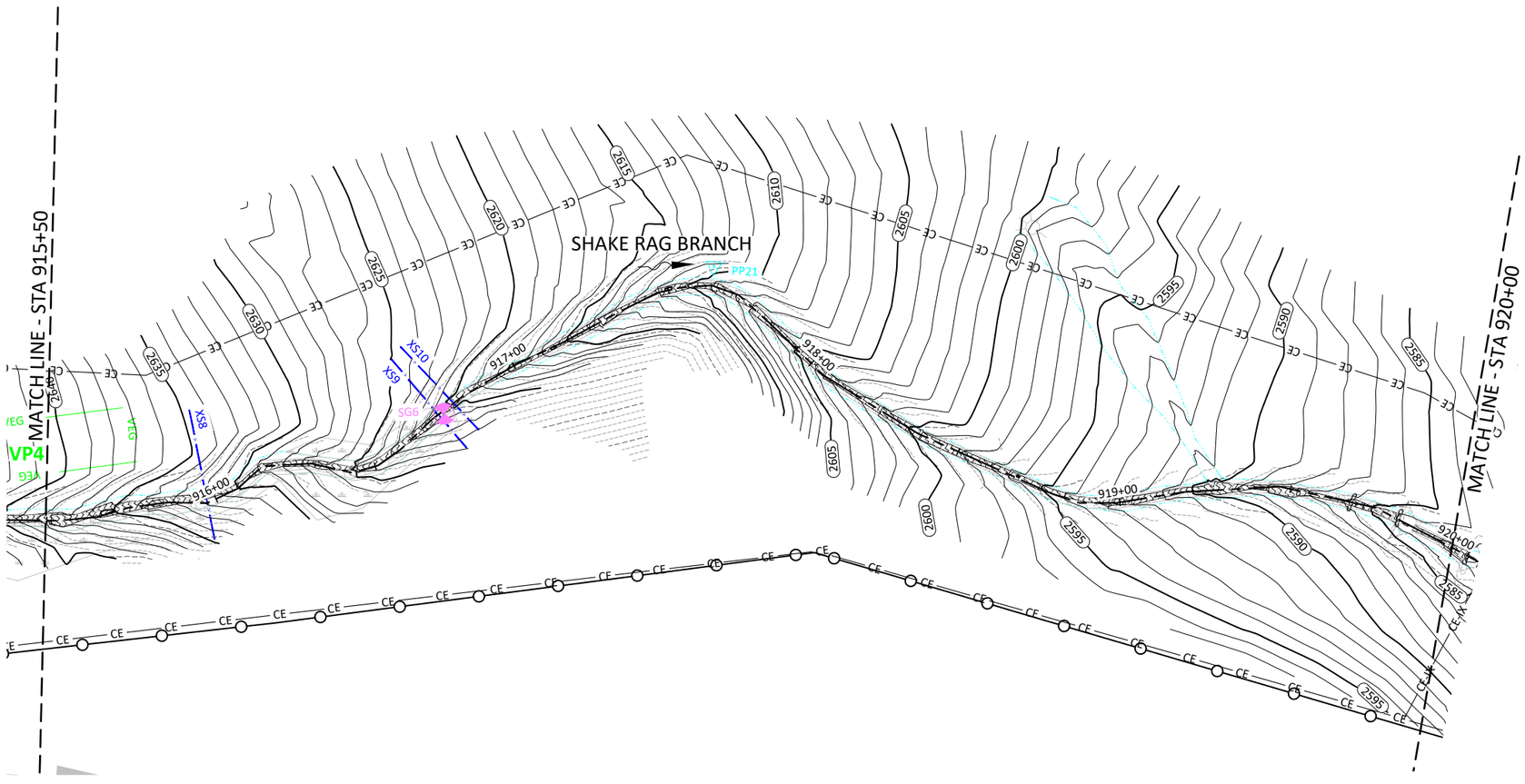

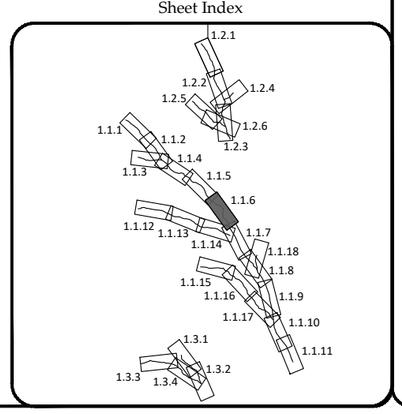

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

Shake Rag Branch
Stream Plan and Profile

Revisions:

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Job Number:	055-02164
Project Engineer:	JNT
Drawn By:	JTH
Checked By:	JK

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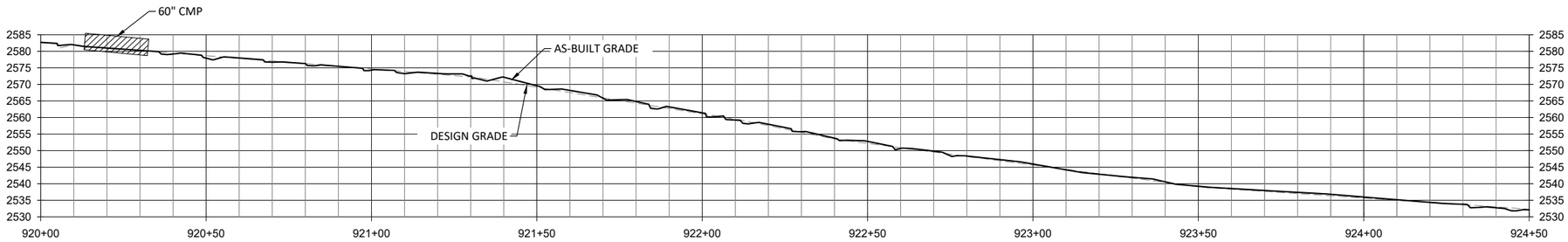

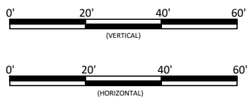

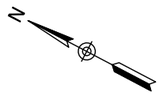

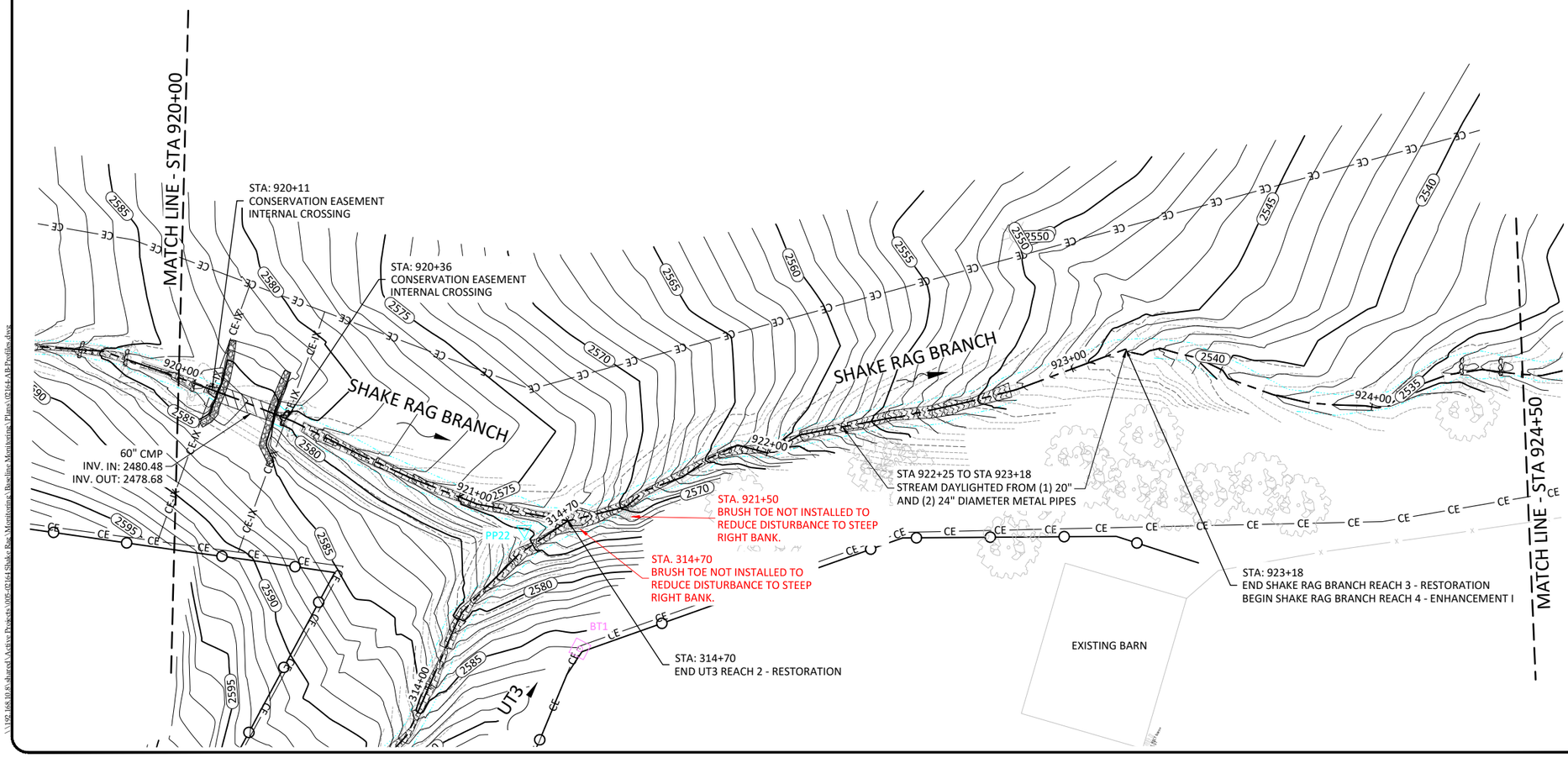

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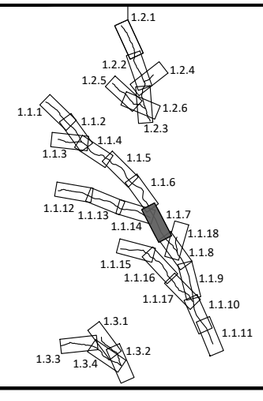

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Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

Shake Rag Branch
Stream Plan and Profile

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Date:	April 23, 2020
Job Number:	055-02164
Project Engineer:	JNT
Drawn By:	JTH1
Checked By:	JK

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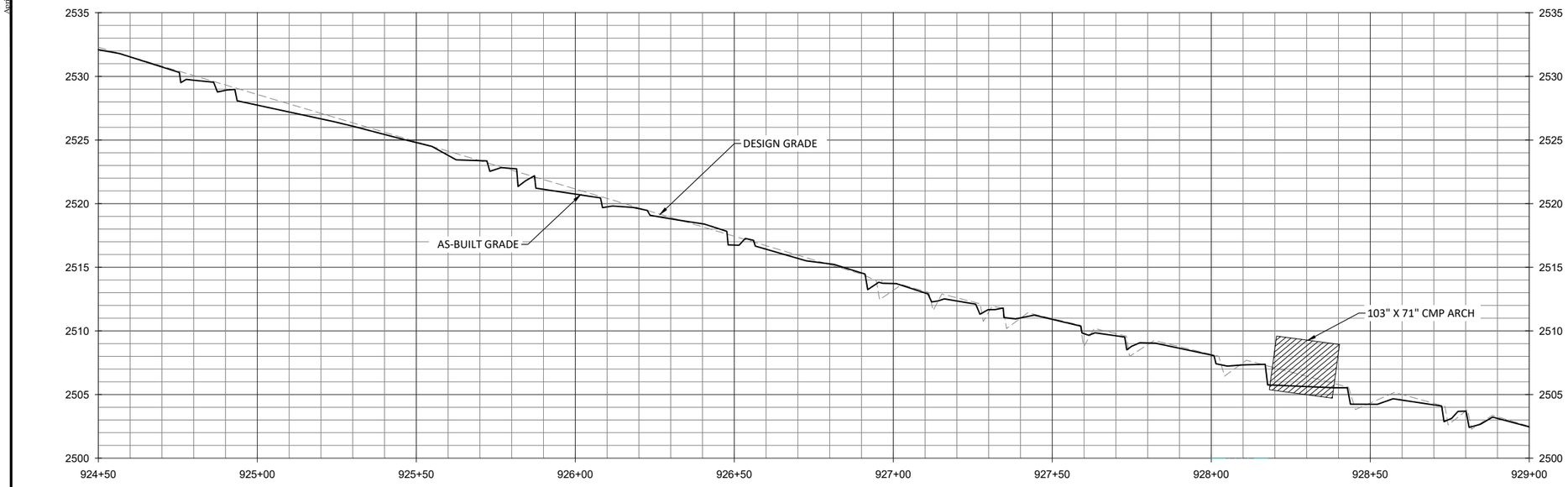

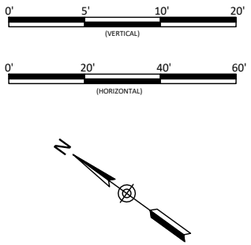

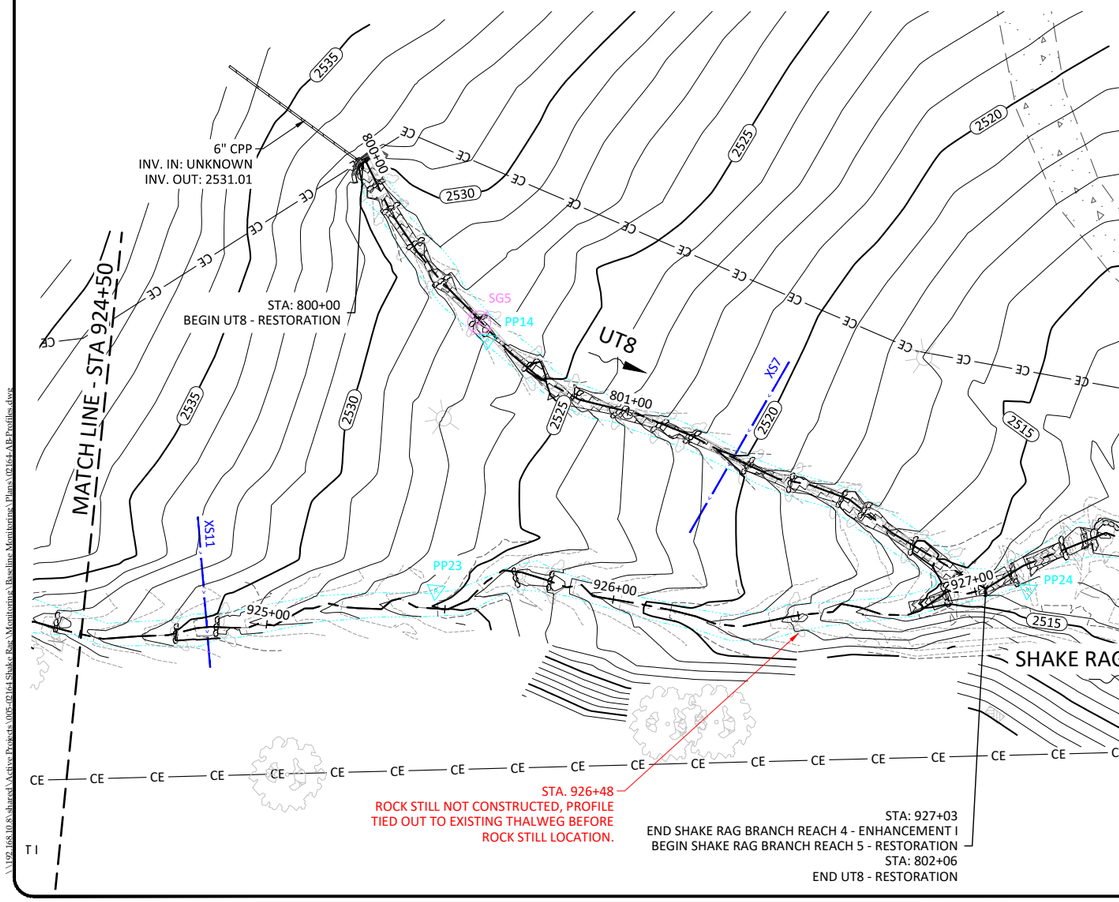

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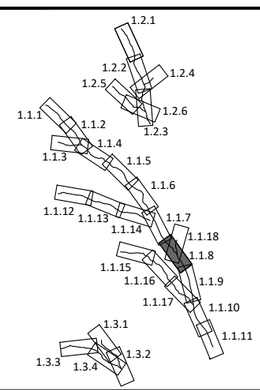

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

Shake Rag Branch
Stream Plan and Profile

Revisions:

Date:	April 23, 2020
Job Number:	055-02164
Project Engineer:	JM
Drawn By:	JTH
Checked By:	JK

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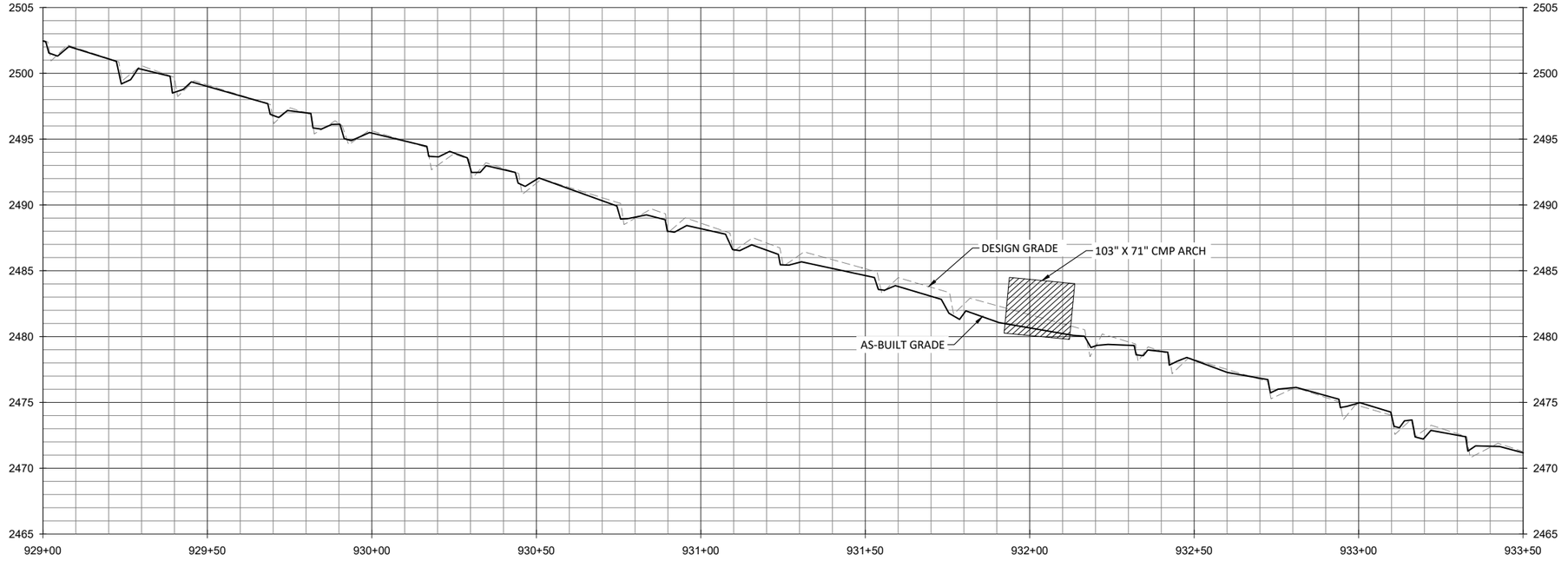

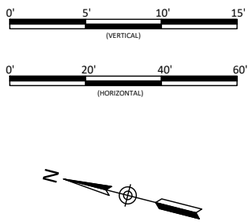

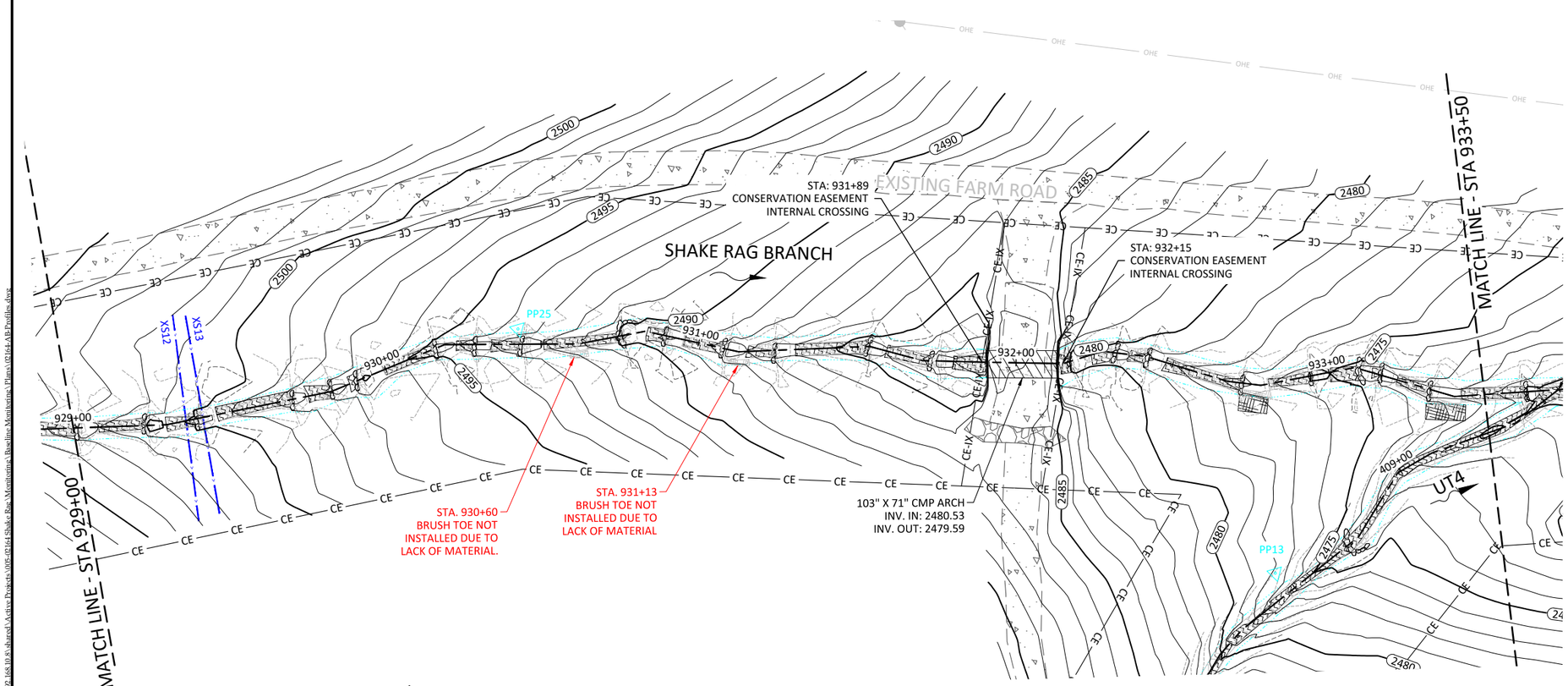

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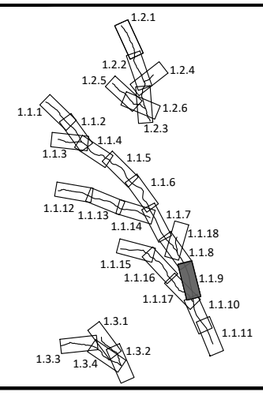

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Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

Shake Rag Branch
Stream Plan and Profile

Revisions:

Date: April 23, 2020
Job Number: 055-02164
Project Engineer: JNT
Drawn By: JTH
Checked By: JK

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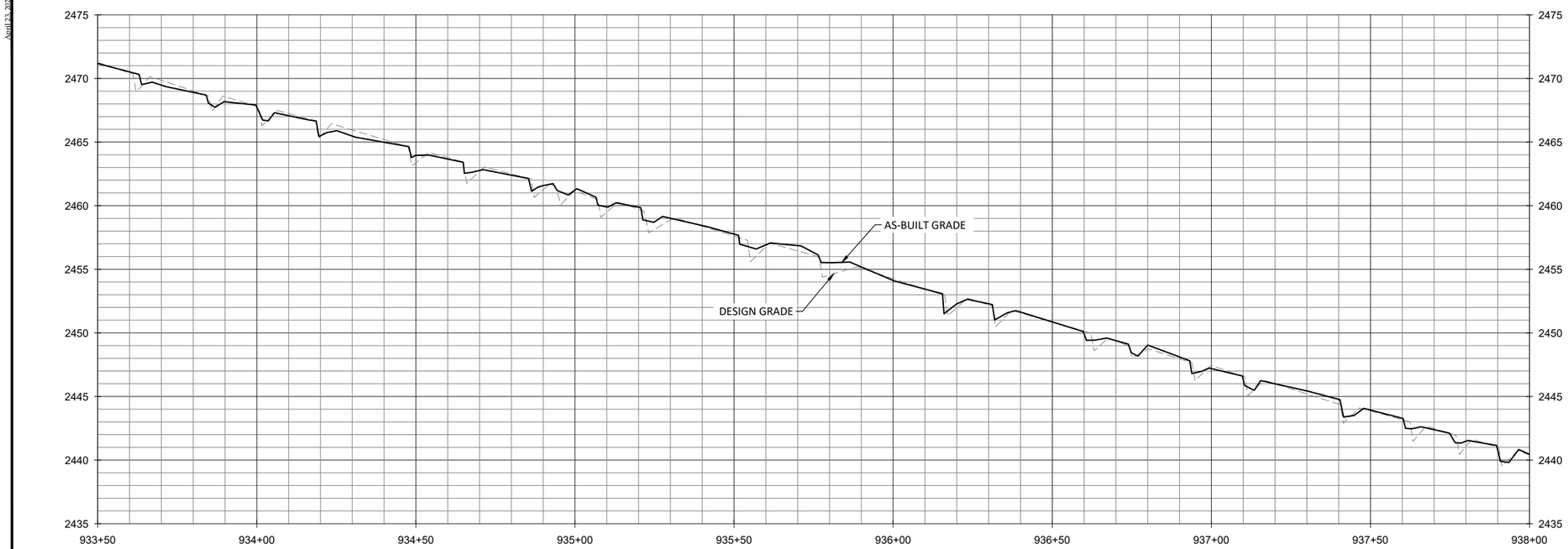

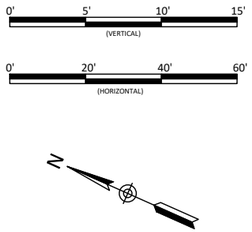

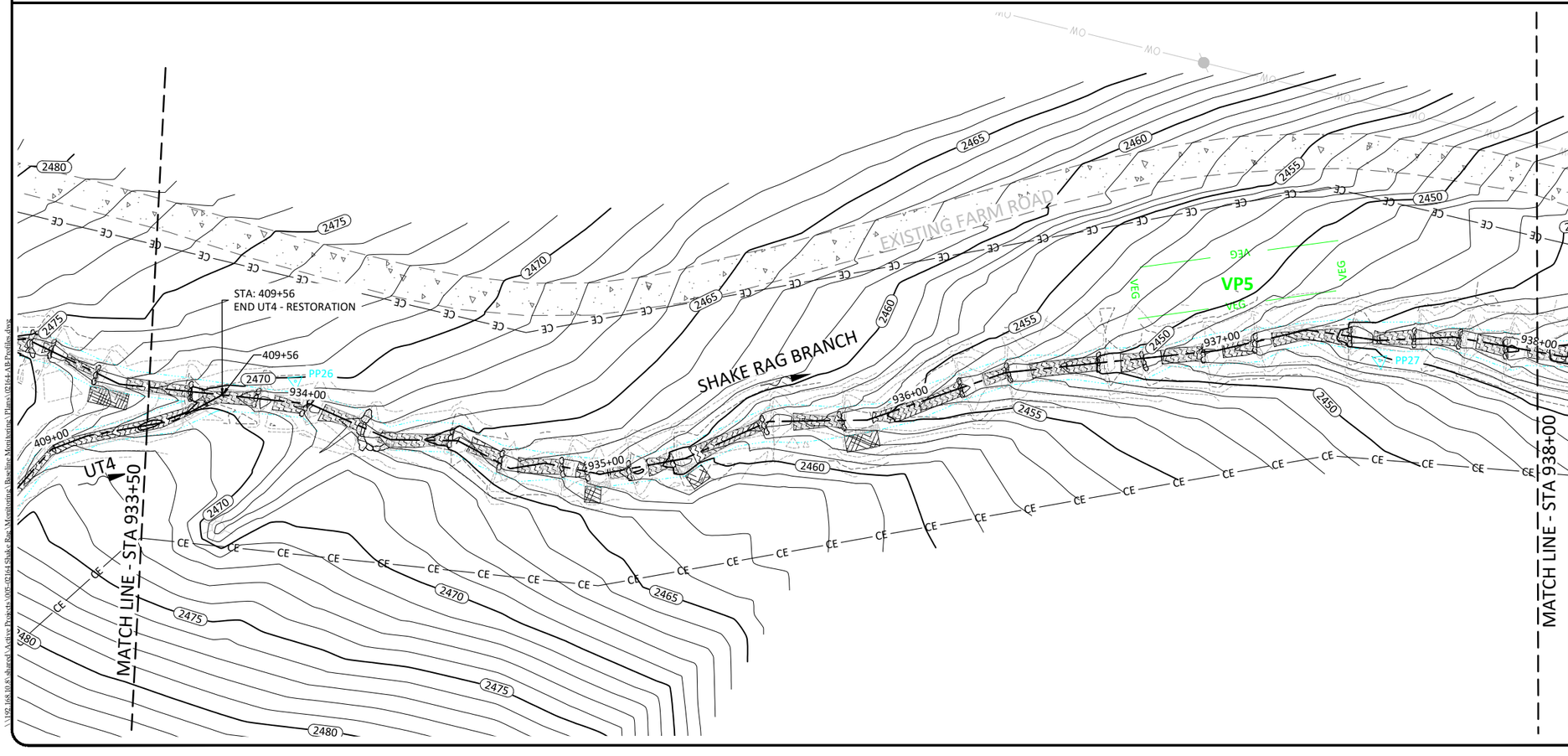

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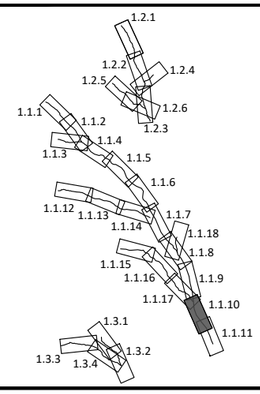

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

Shake Rag Branch
Stream Plan and Profile

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Drawn By:	JTH
Checked By:	JK

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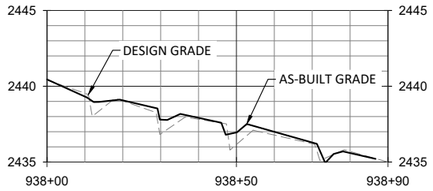
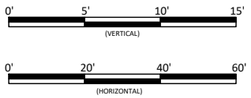
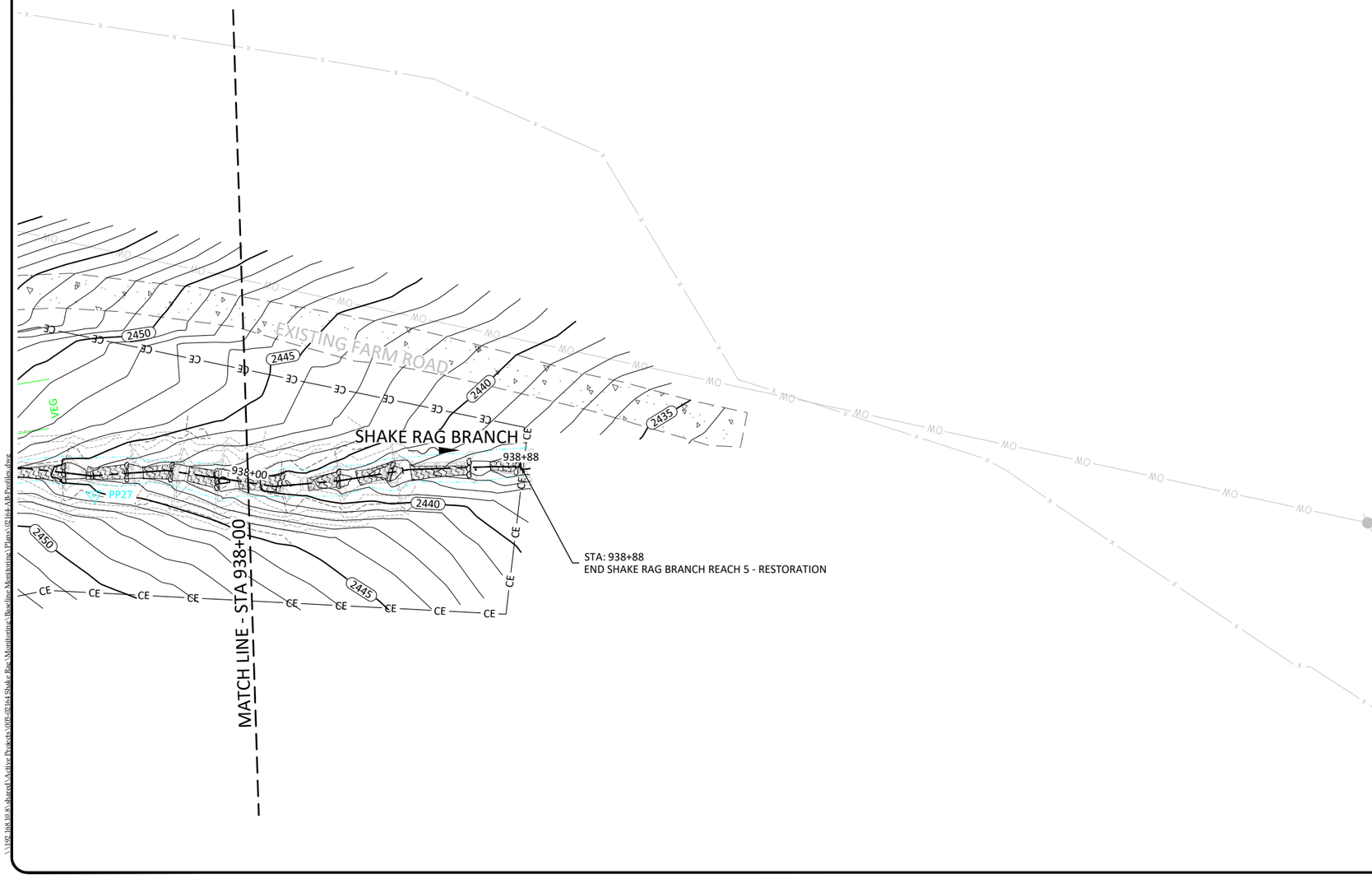
April 23, 2020







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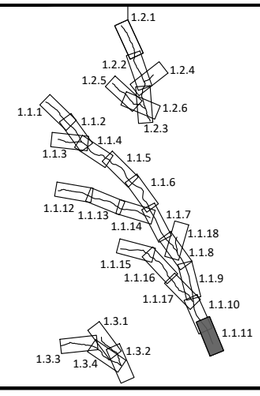

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Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

Shake Rag Branch
Stream Plan and Profile

Revisions:

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Drawn By:	JTH
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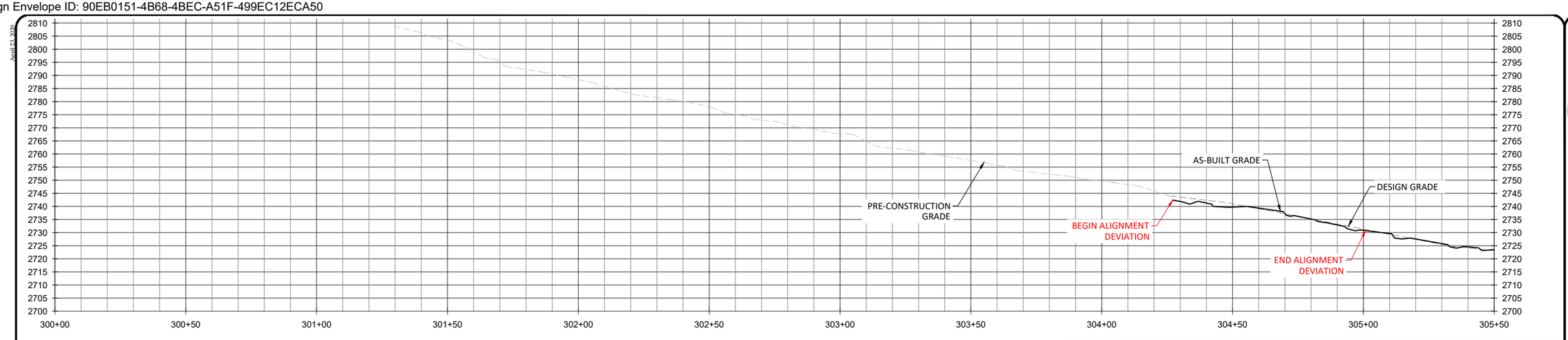

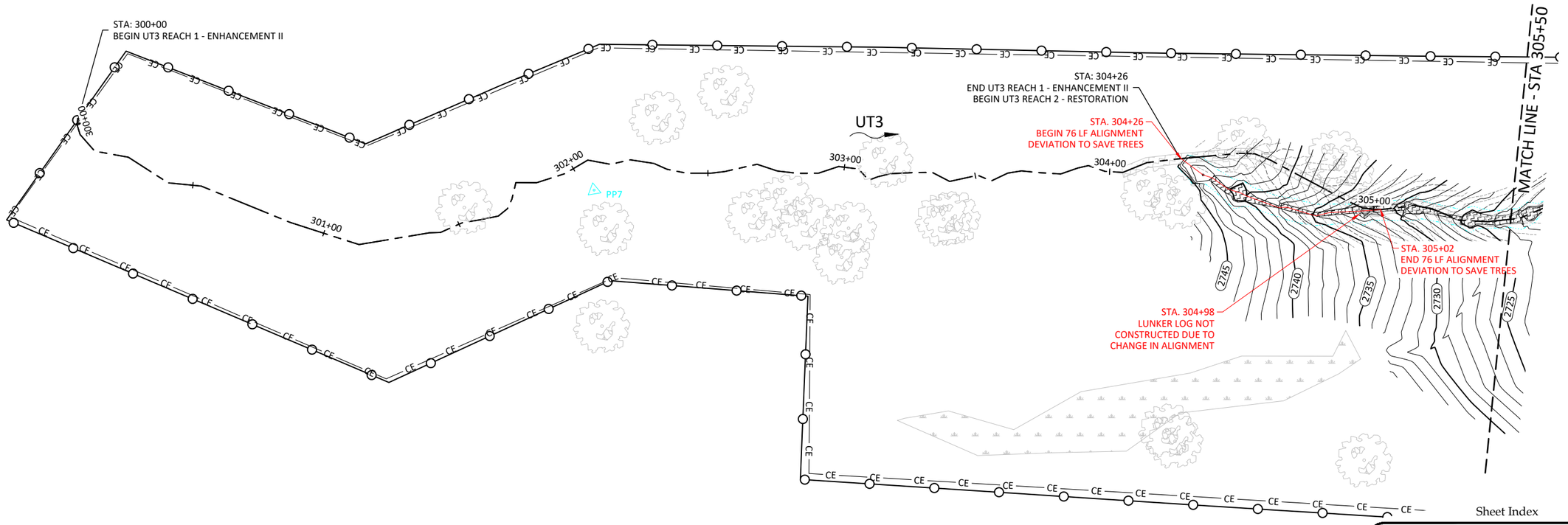

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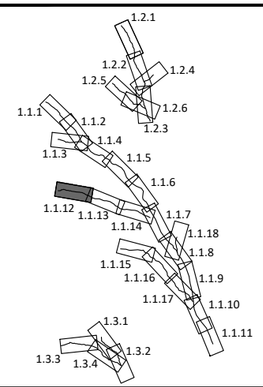

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

UT3
Stream Plan and Profile

Revisions:

Date: April 23, 2020
Job Number: 055-02164
Project Engineer: JM
Drawn By: JTH
Checked By: JK

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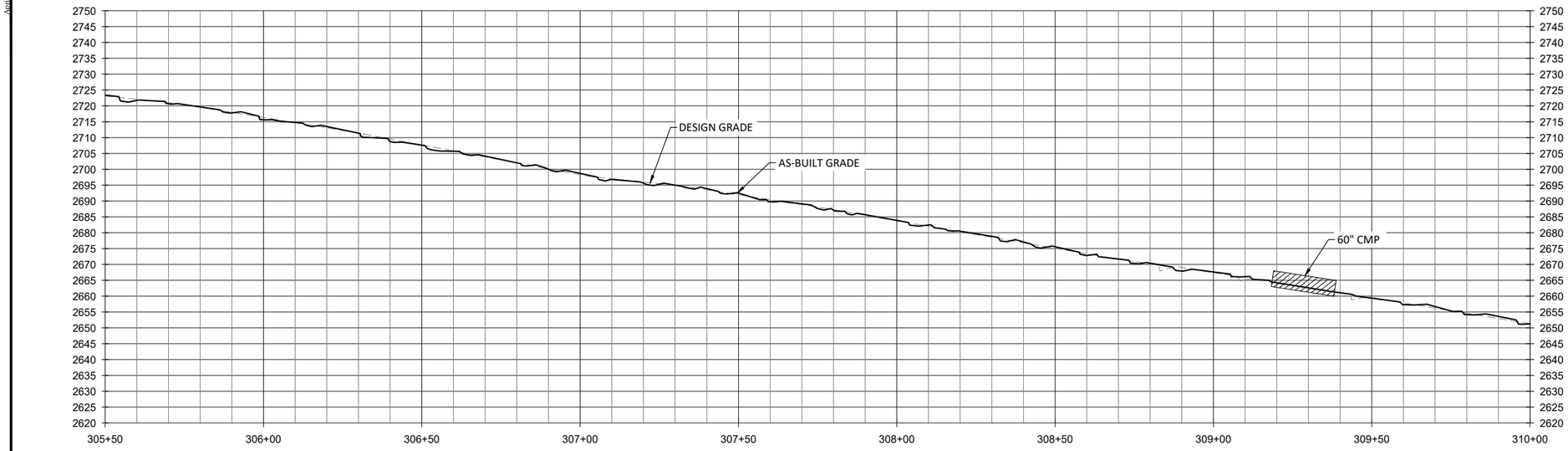

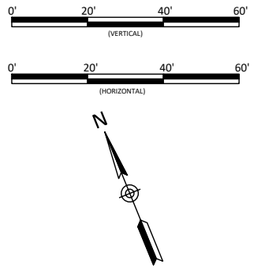

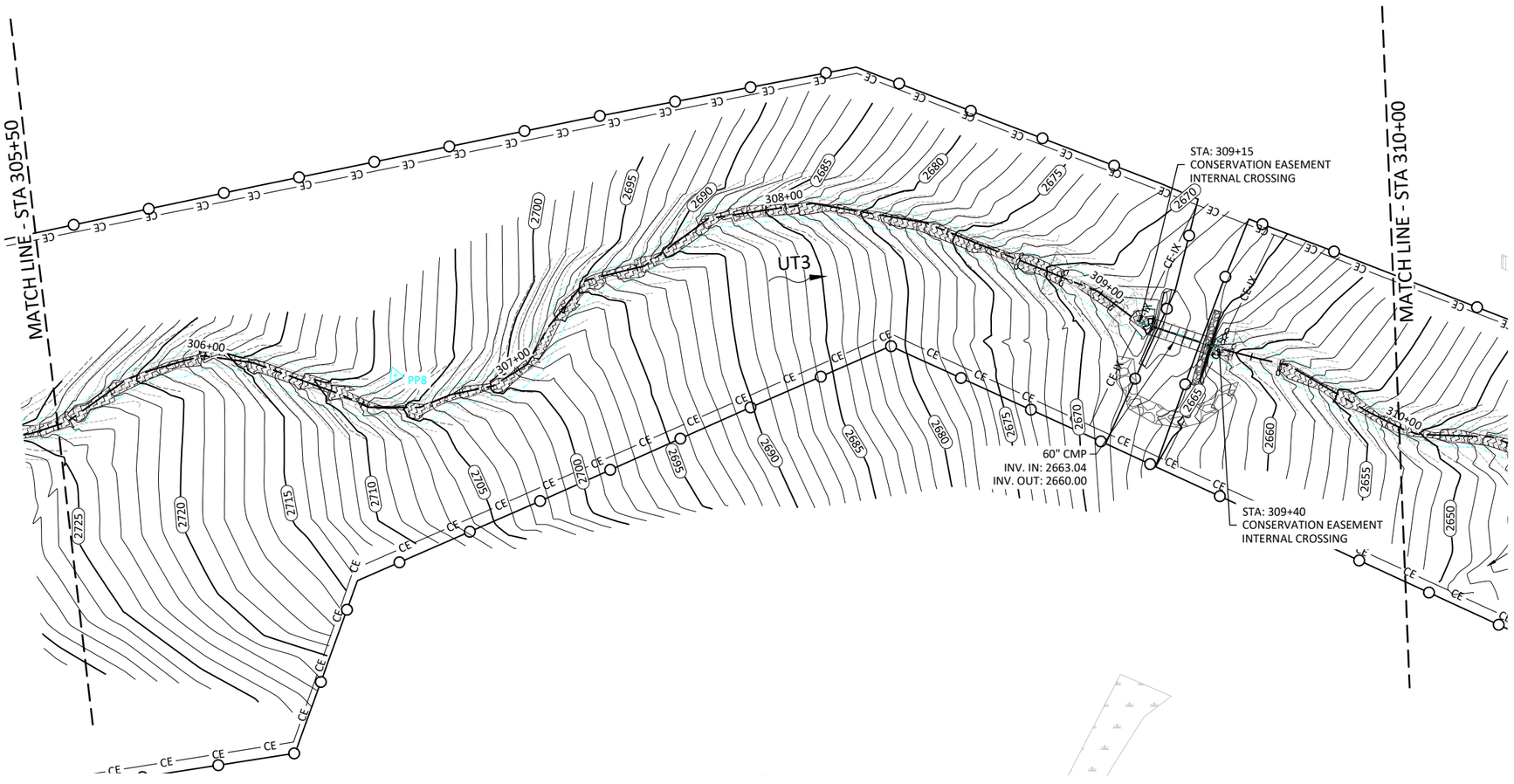

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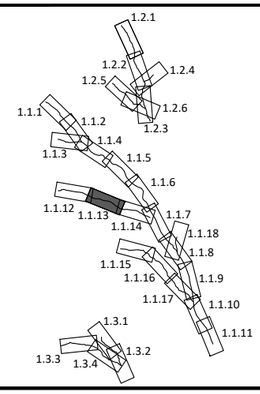

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Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

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Drawn By: JTH
Checked By: JK

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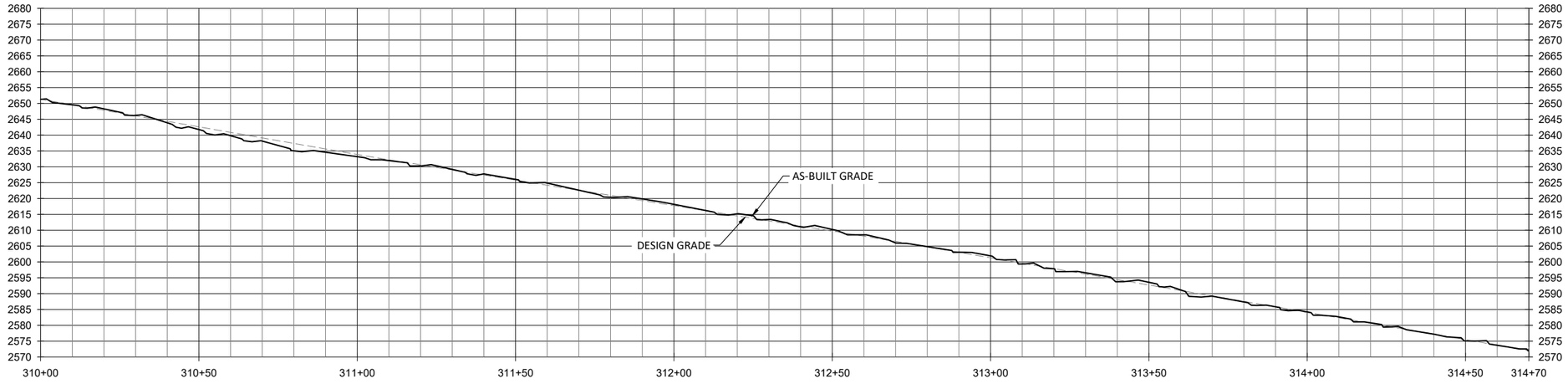
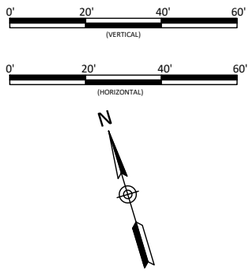
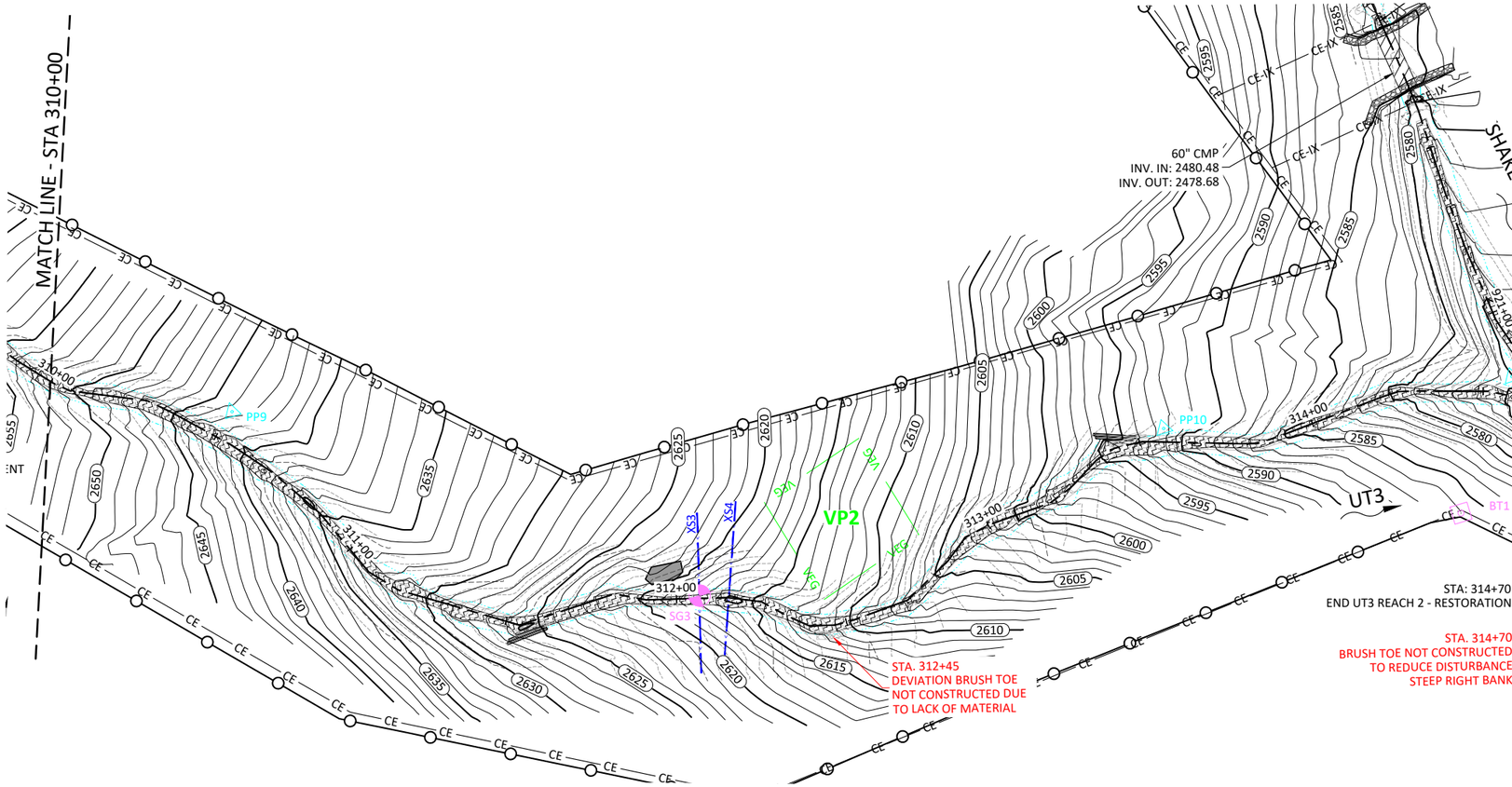
\\VS2-16\10 JC-Shared\Active Projects\055-02164 Shake Rag Monitoring\Baseline Monitoring\Plans\02164 XS Profiles.dwg
April 23, 2020







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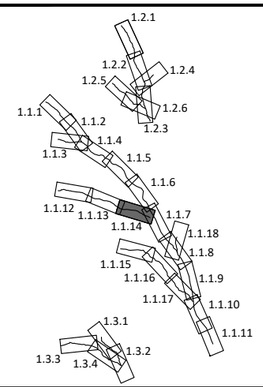

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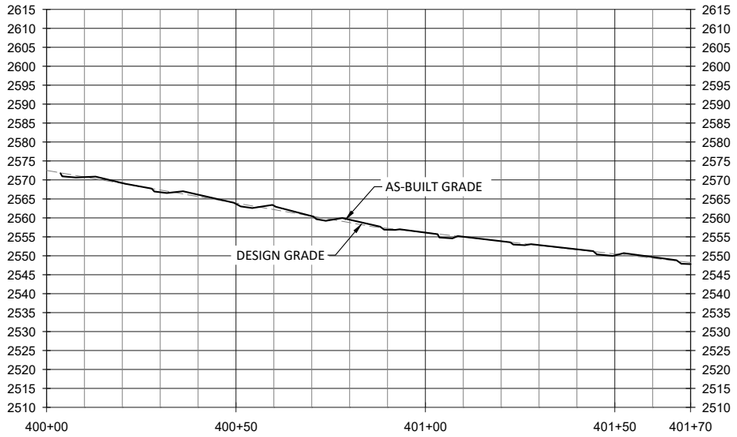

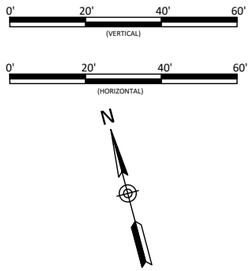

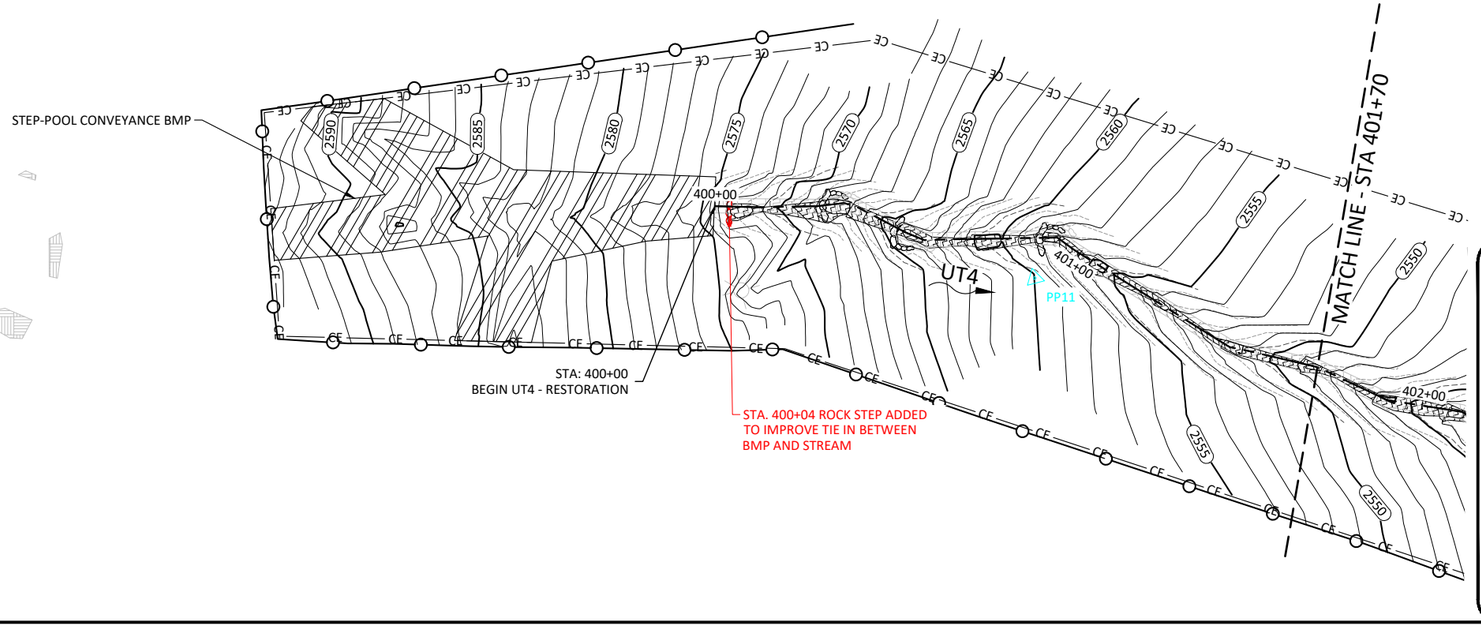

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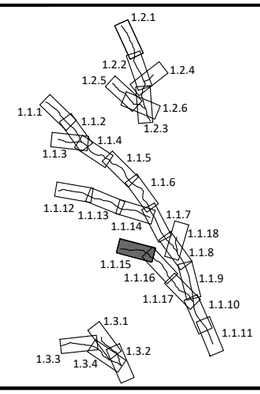

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Shake Rag Branch Mitigation Site Record Drawings
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Checked By: JK

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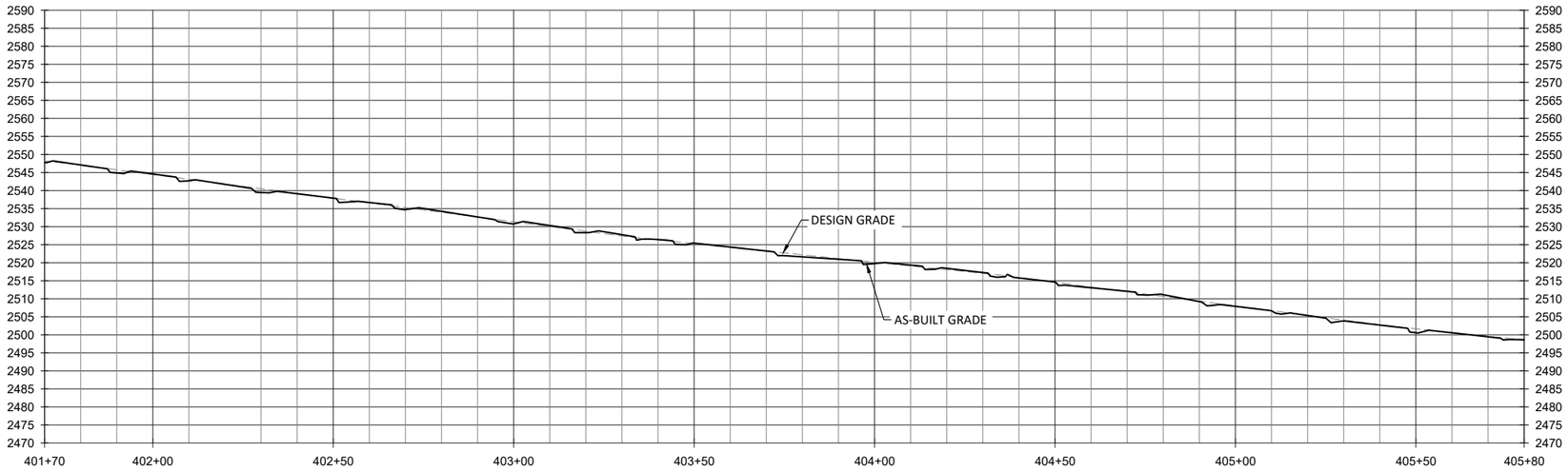

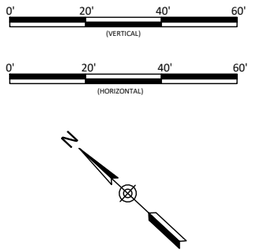

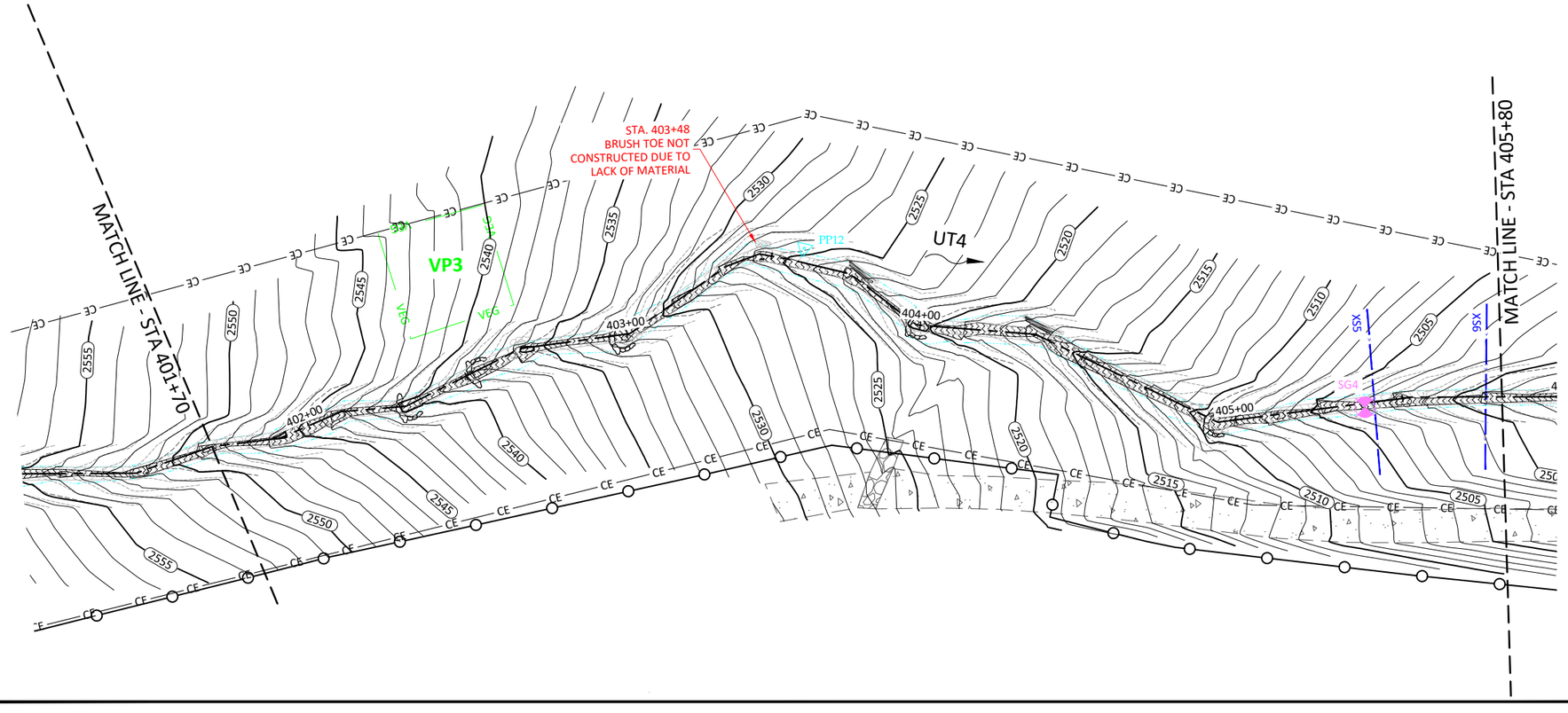

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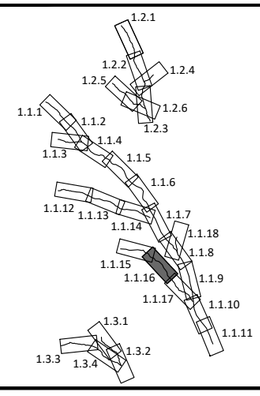

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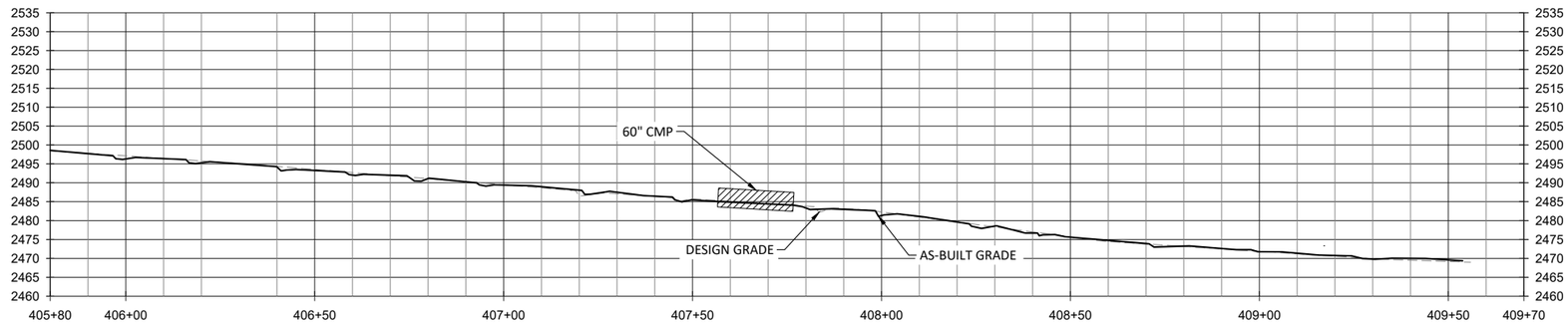

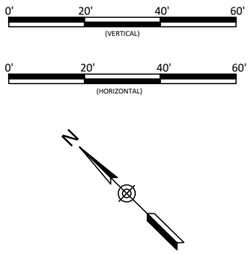

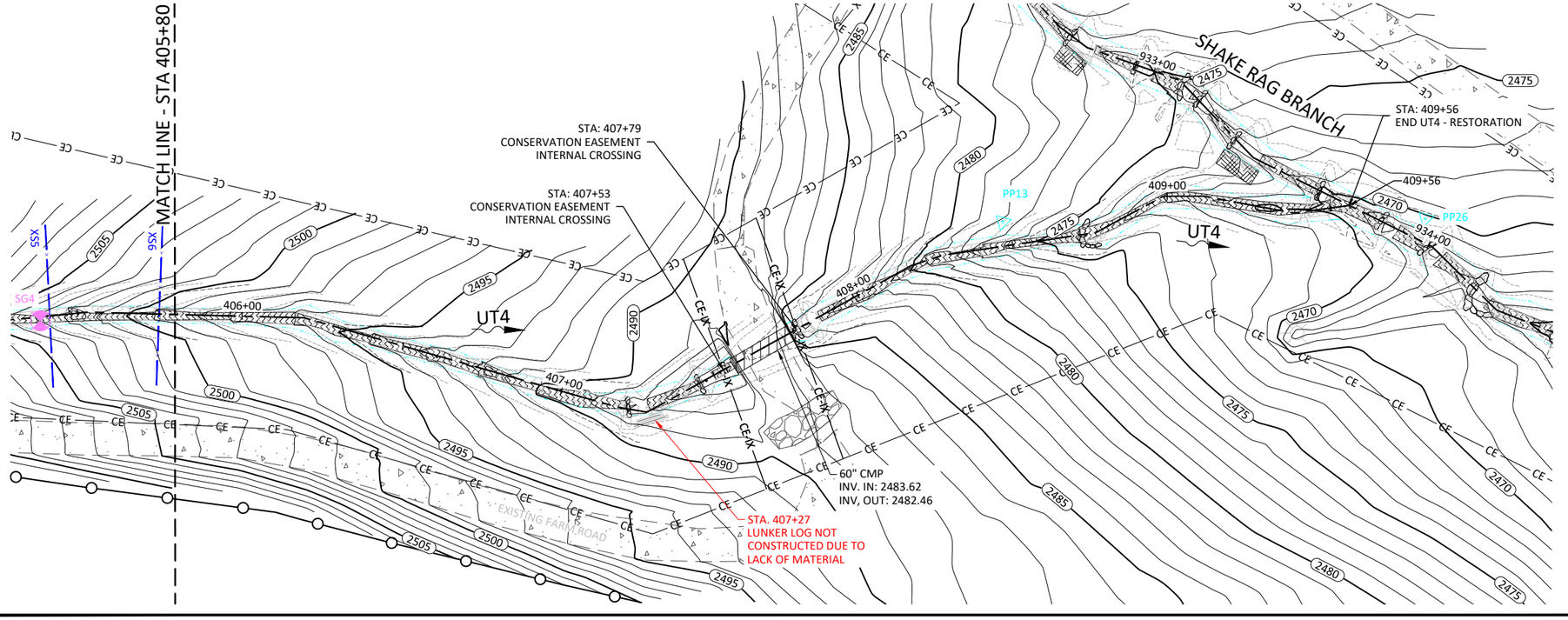

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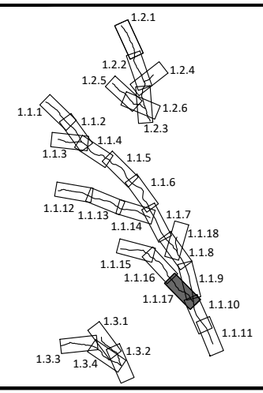

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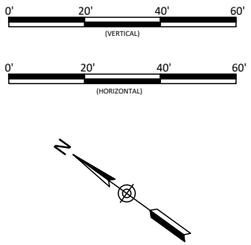

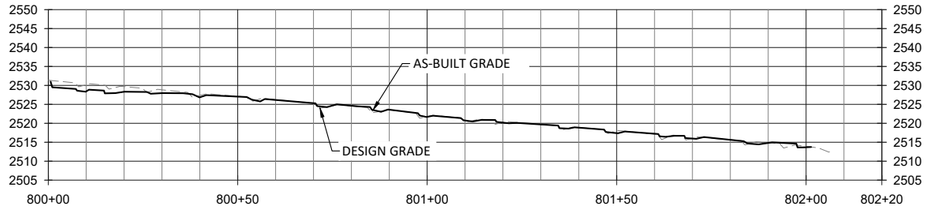

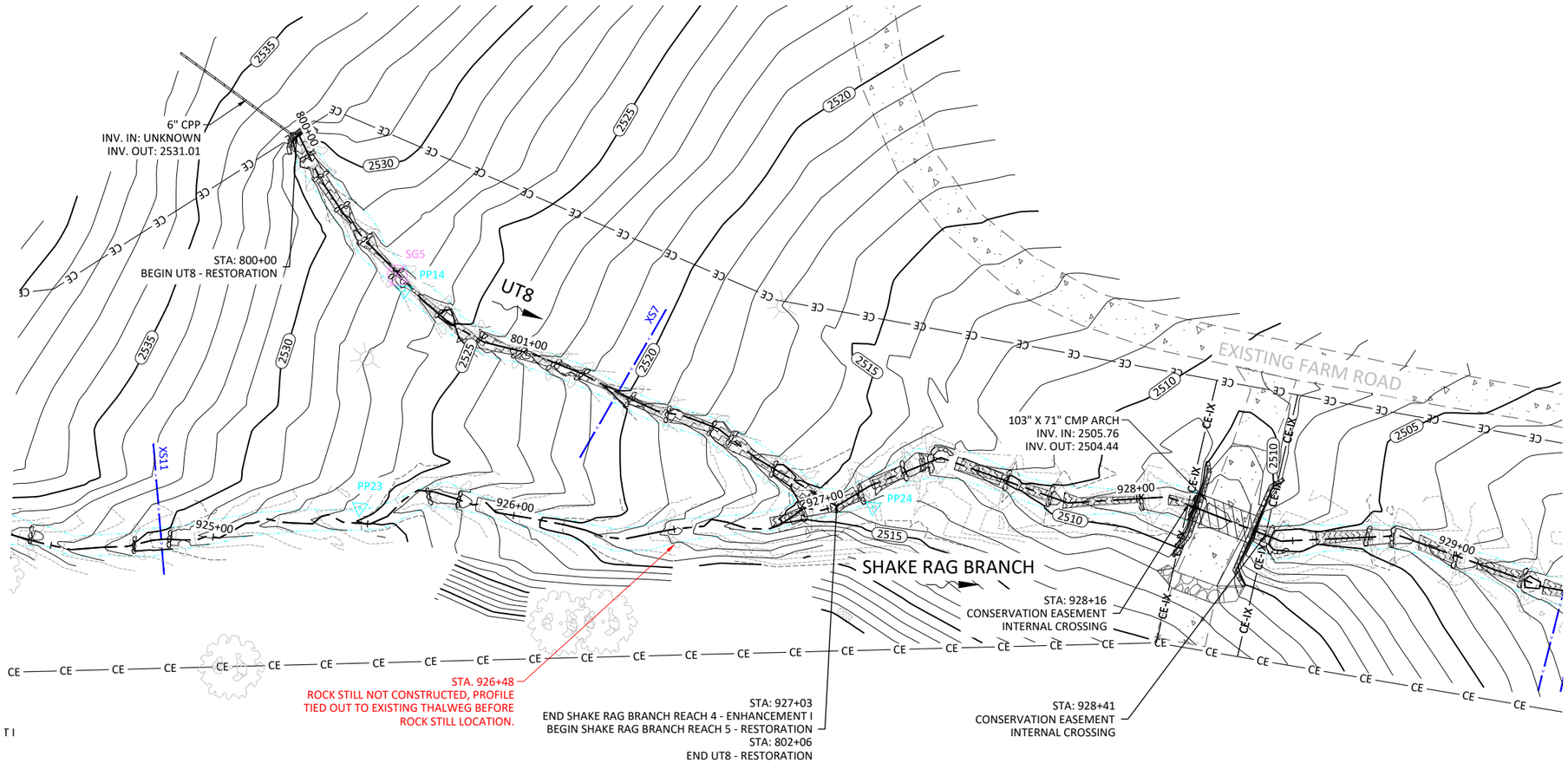

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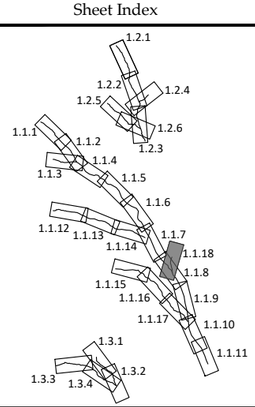

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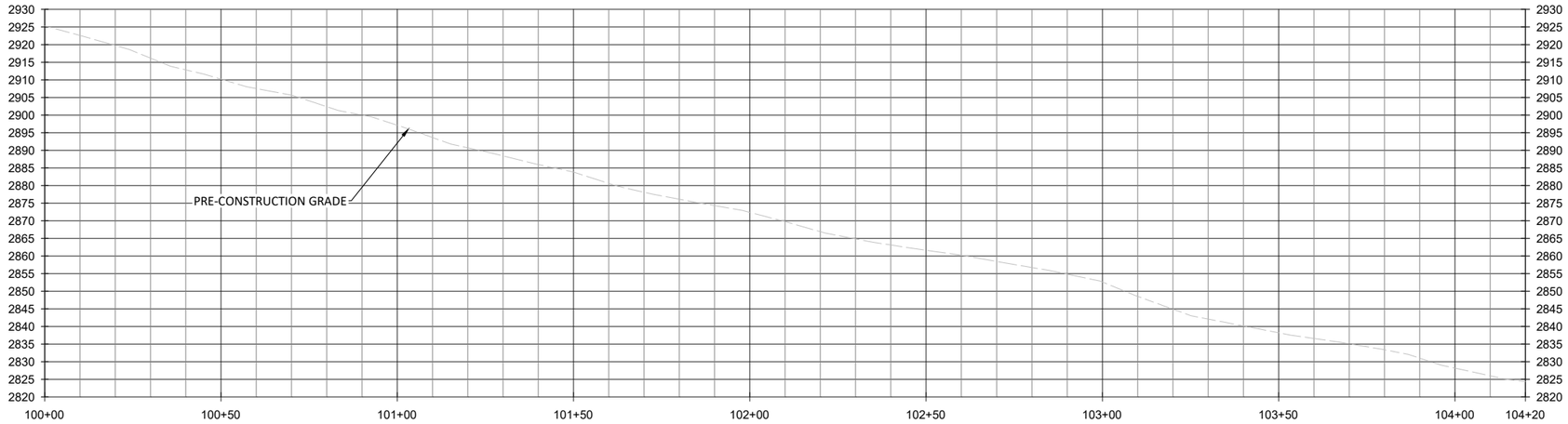

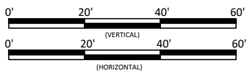

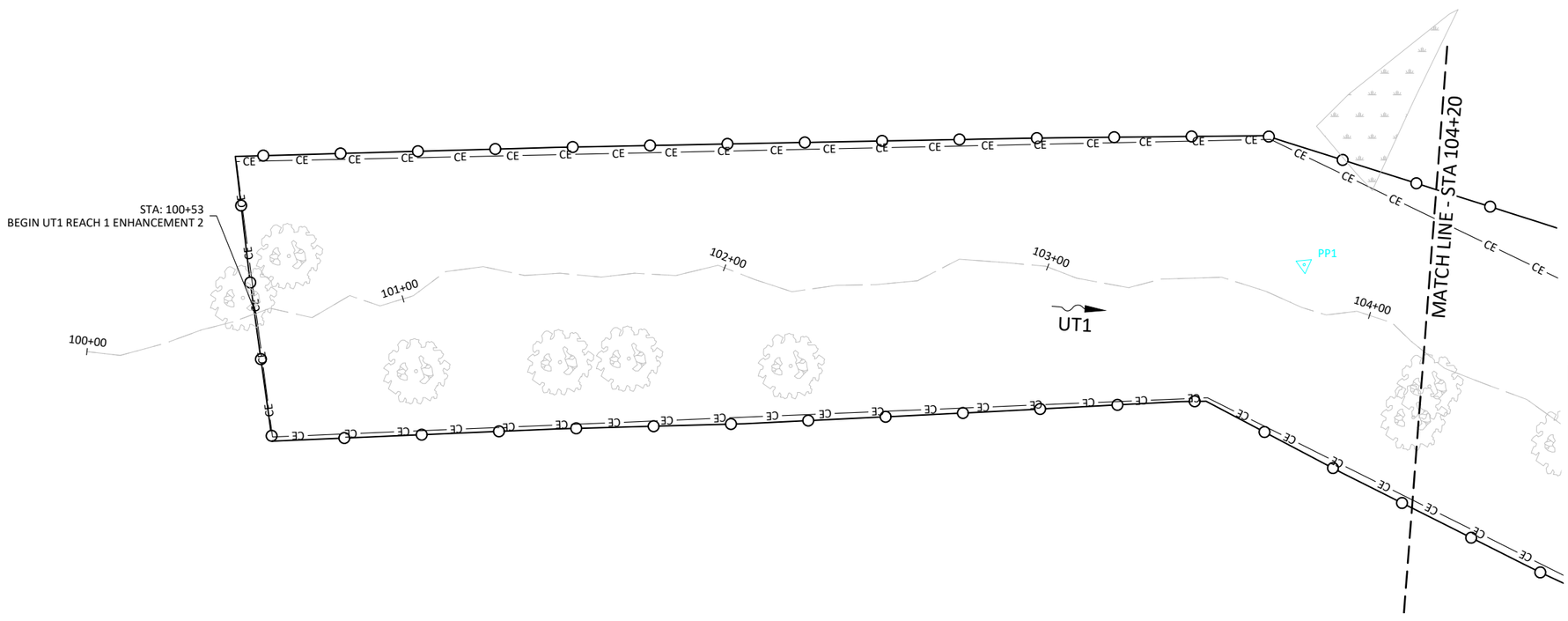

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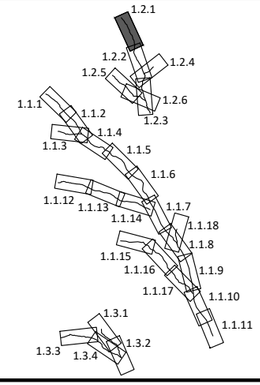

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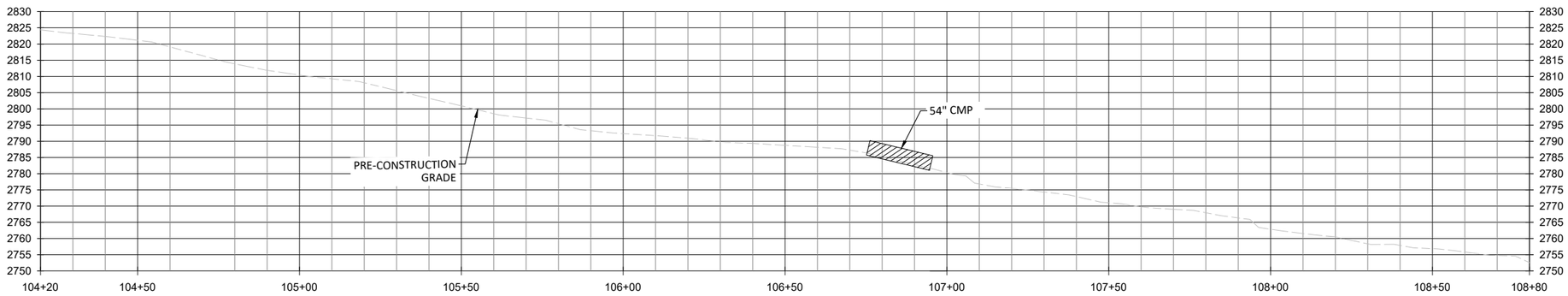

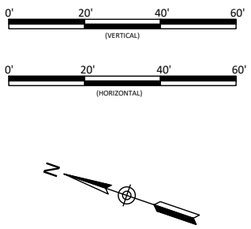

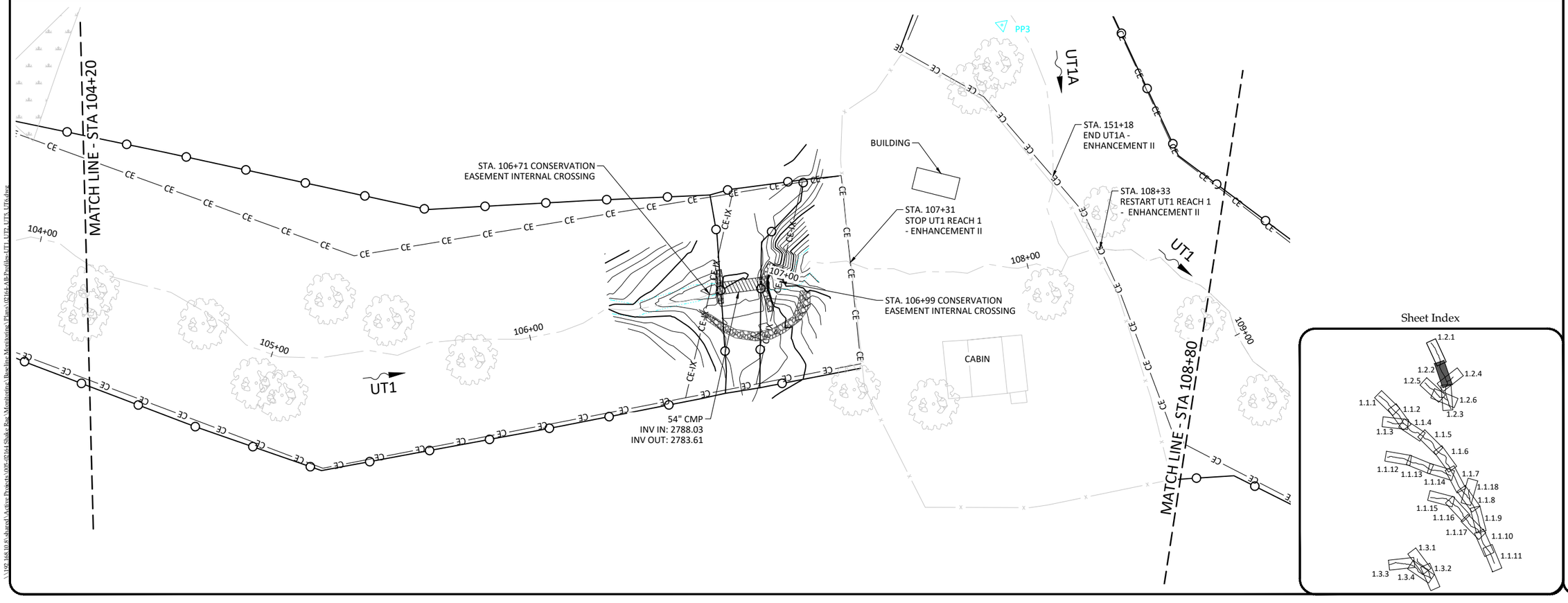

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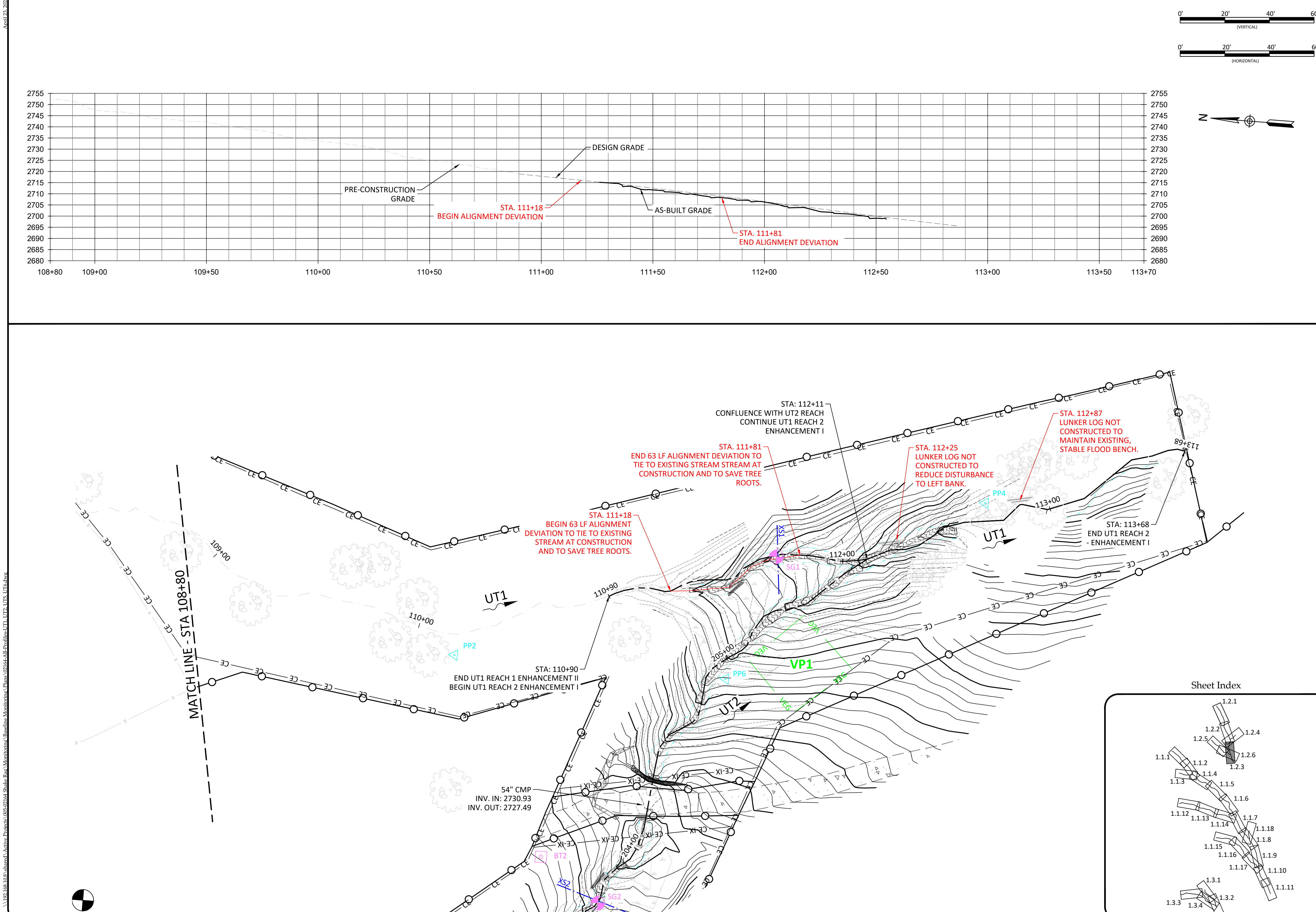

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Checked By: JK

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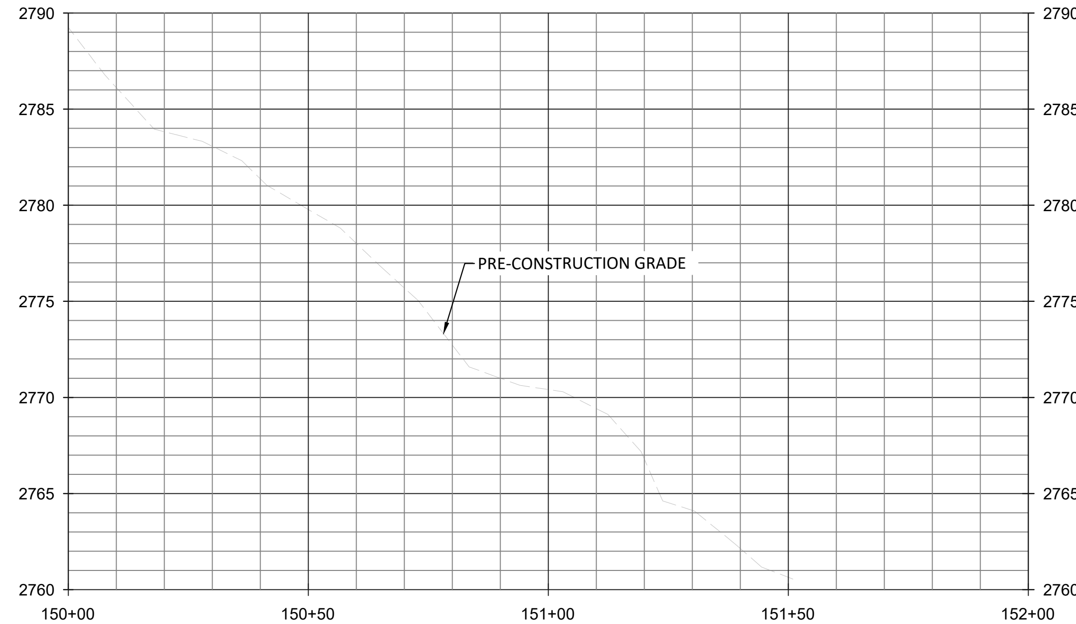

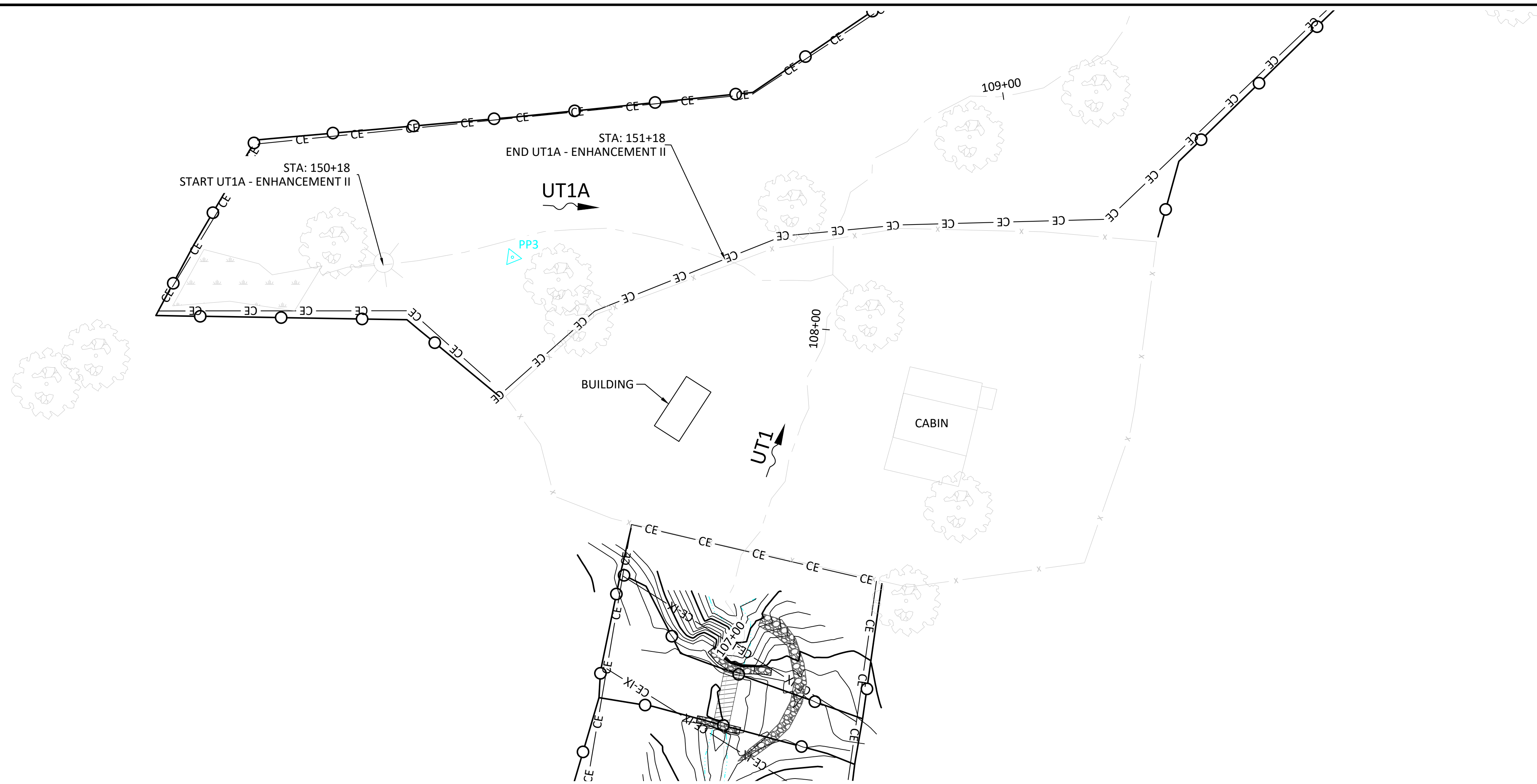

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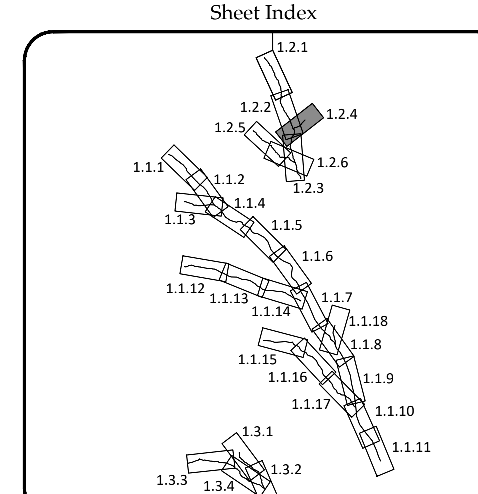

Shake Rag Branch Mitigation Site Record Drawings
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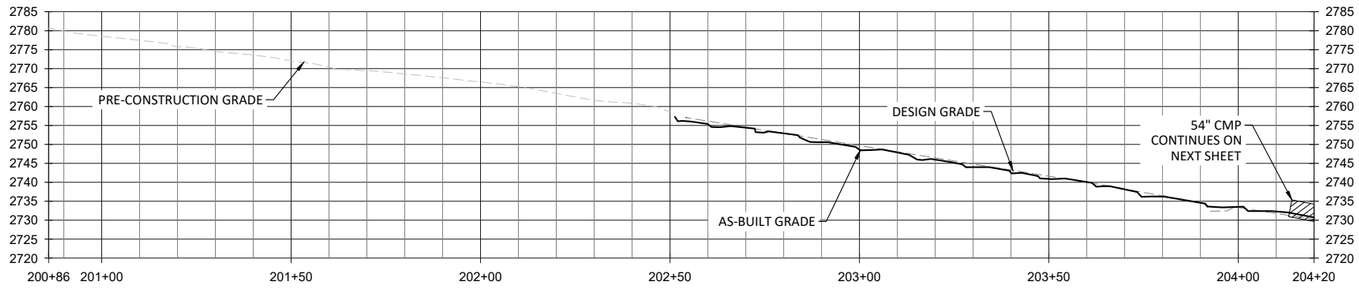

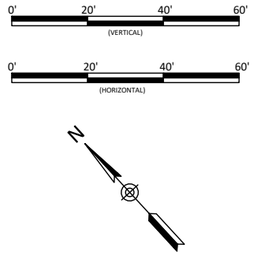

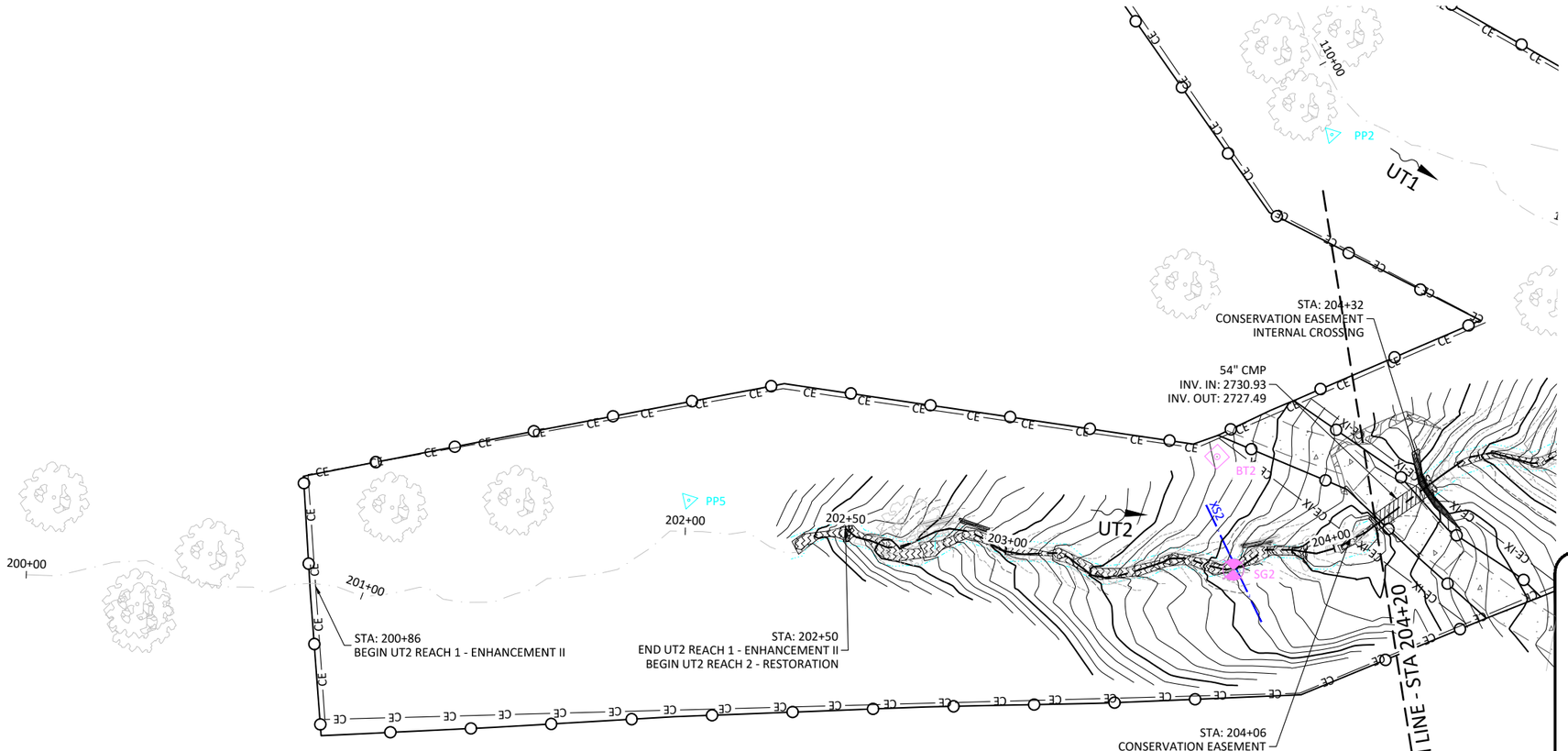

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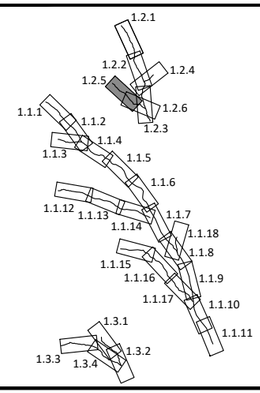

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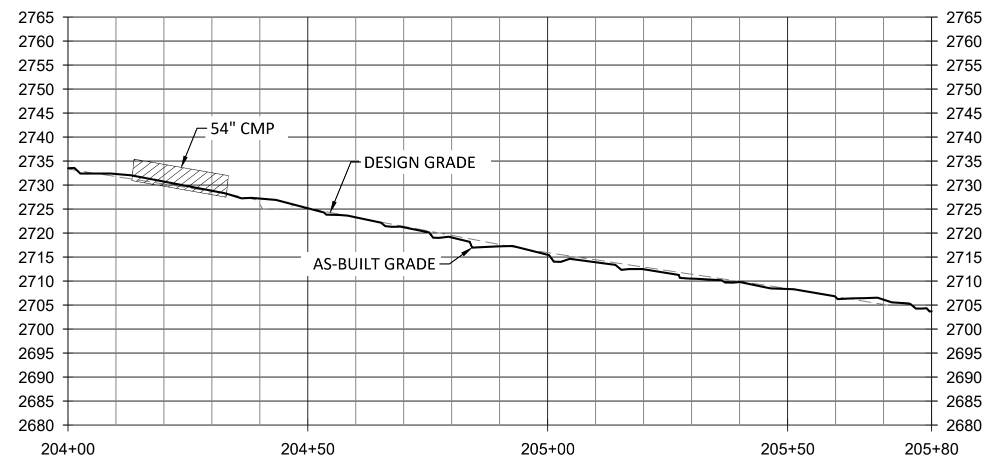

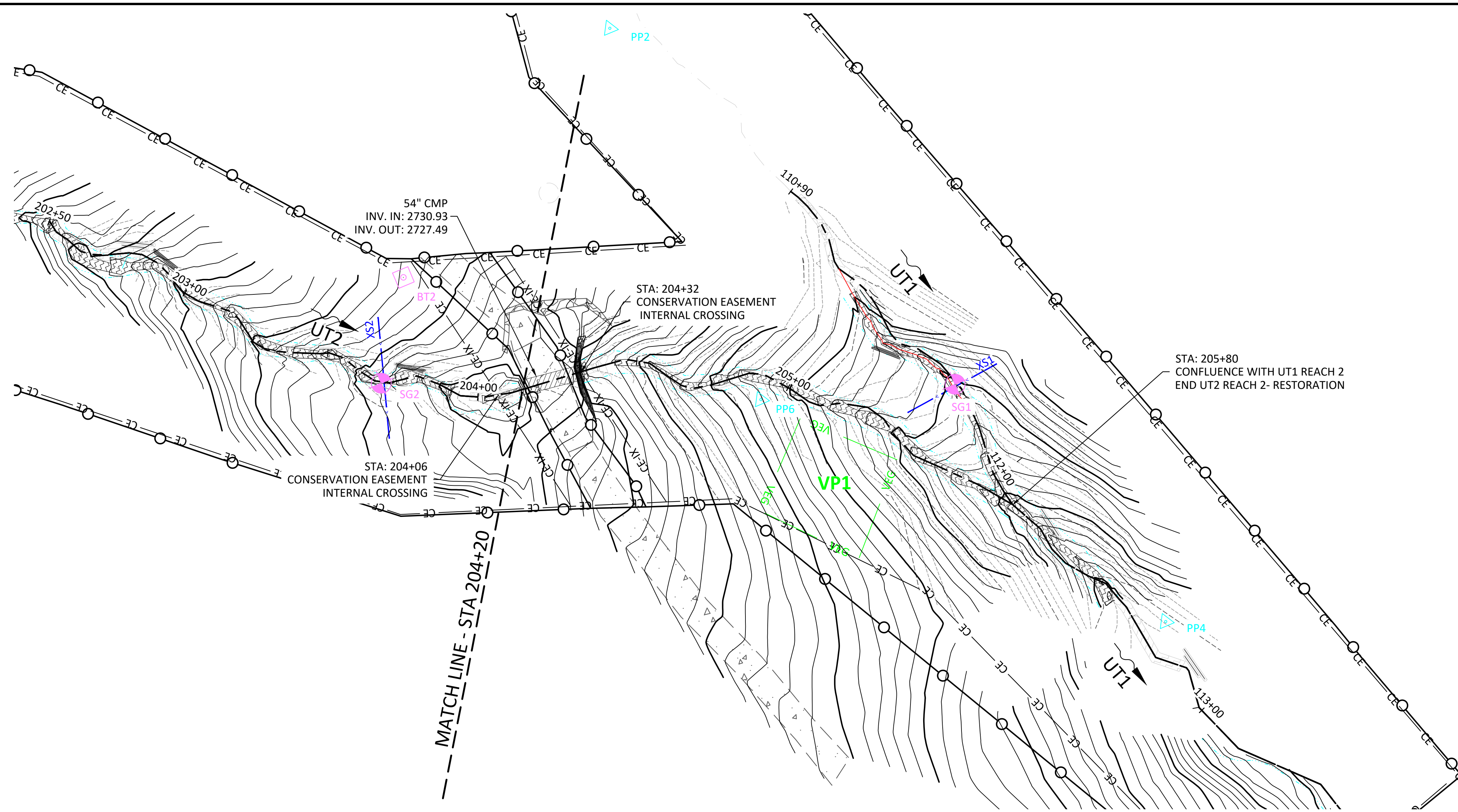

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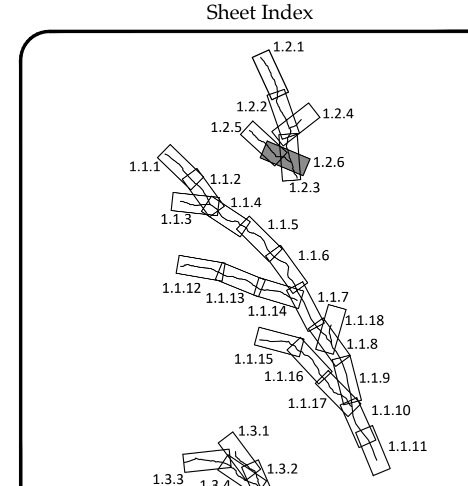

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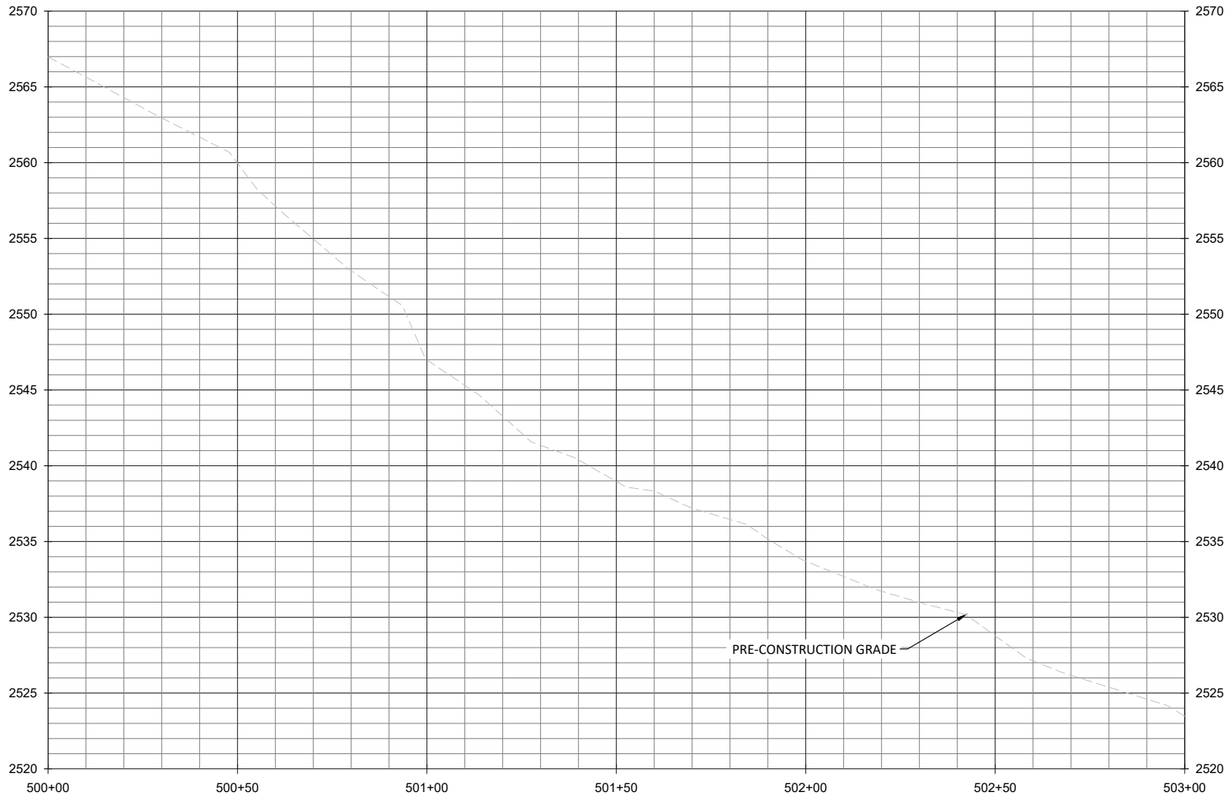

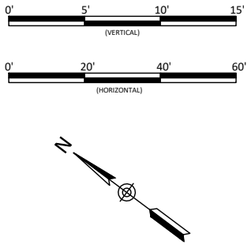

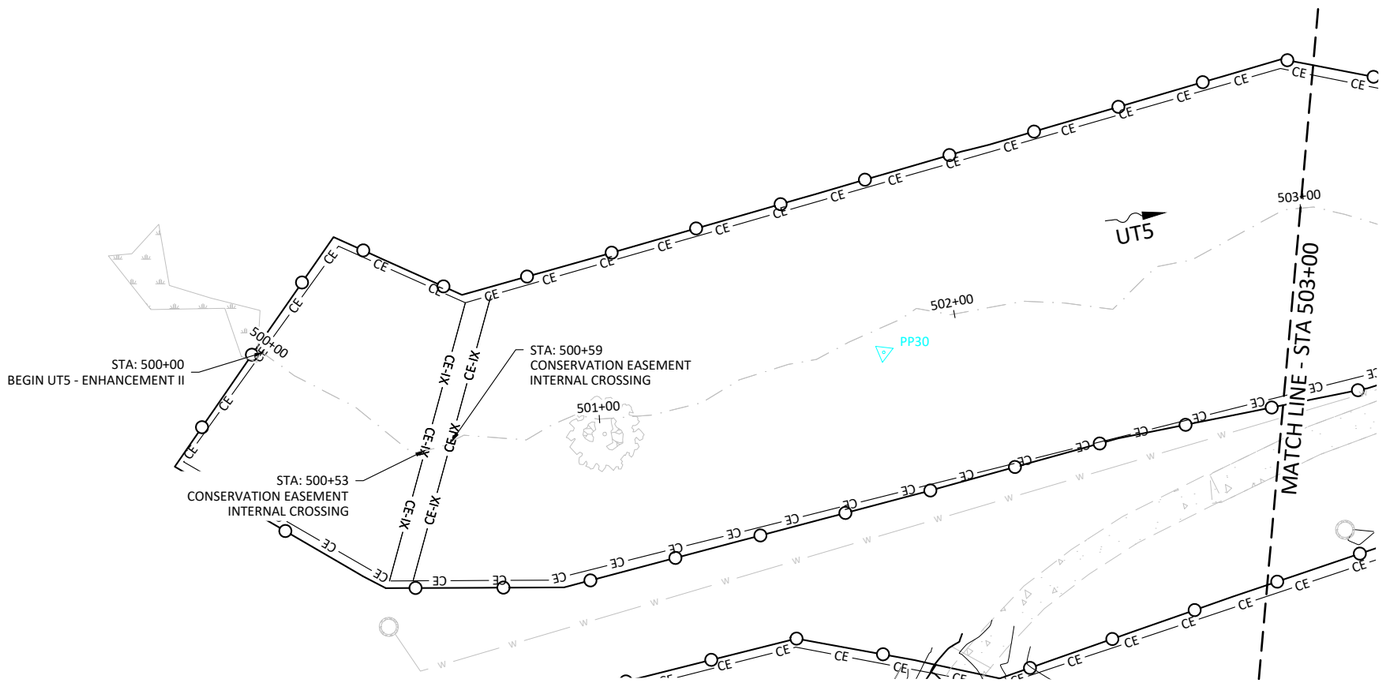

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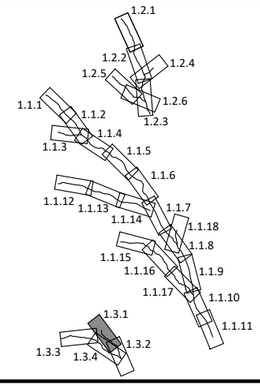

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Checked By: JK

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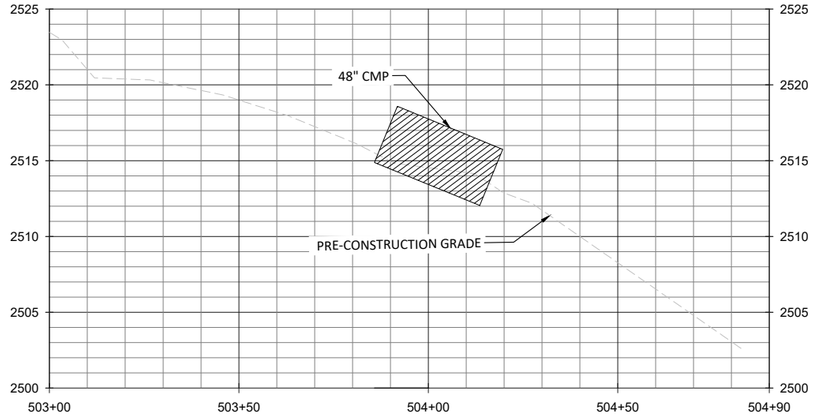

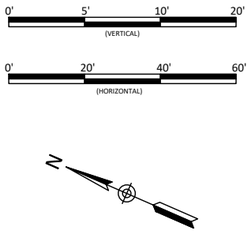

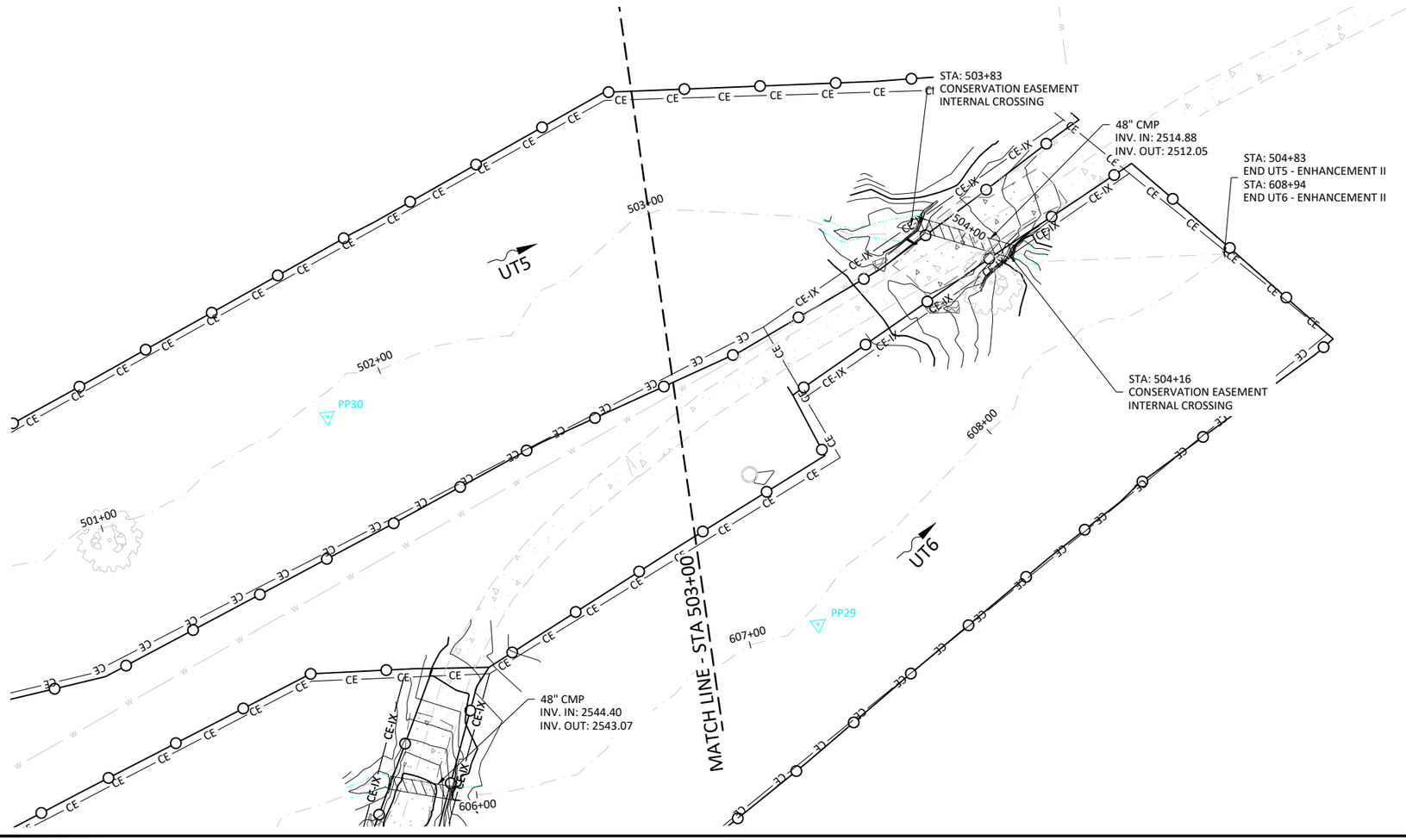

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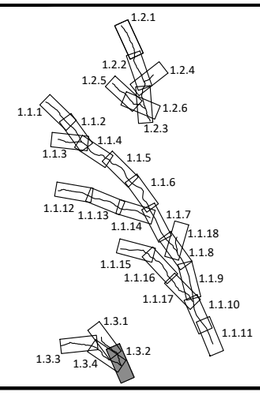

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Checked By:	JK

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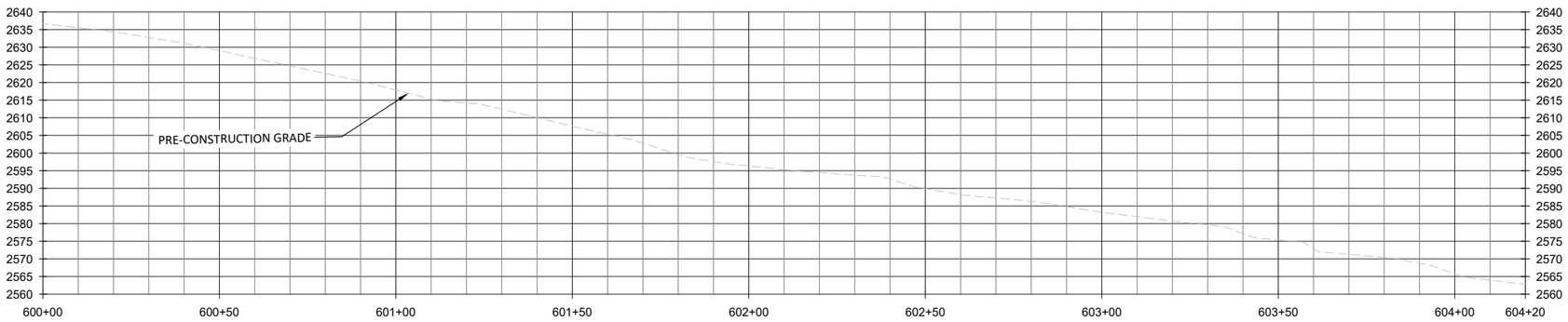

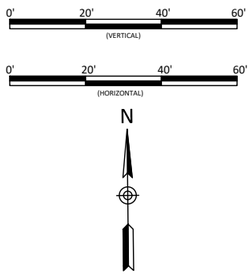

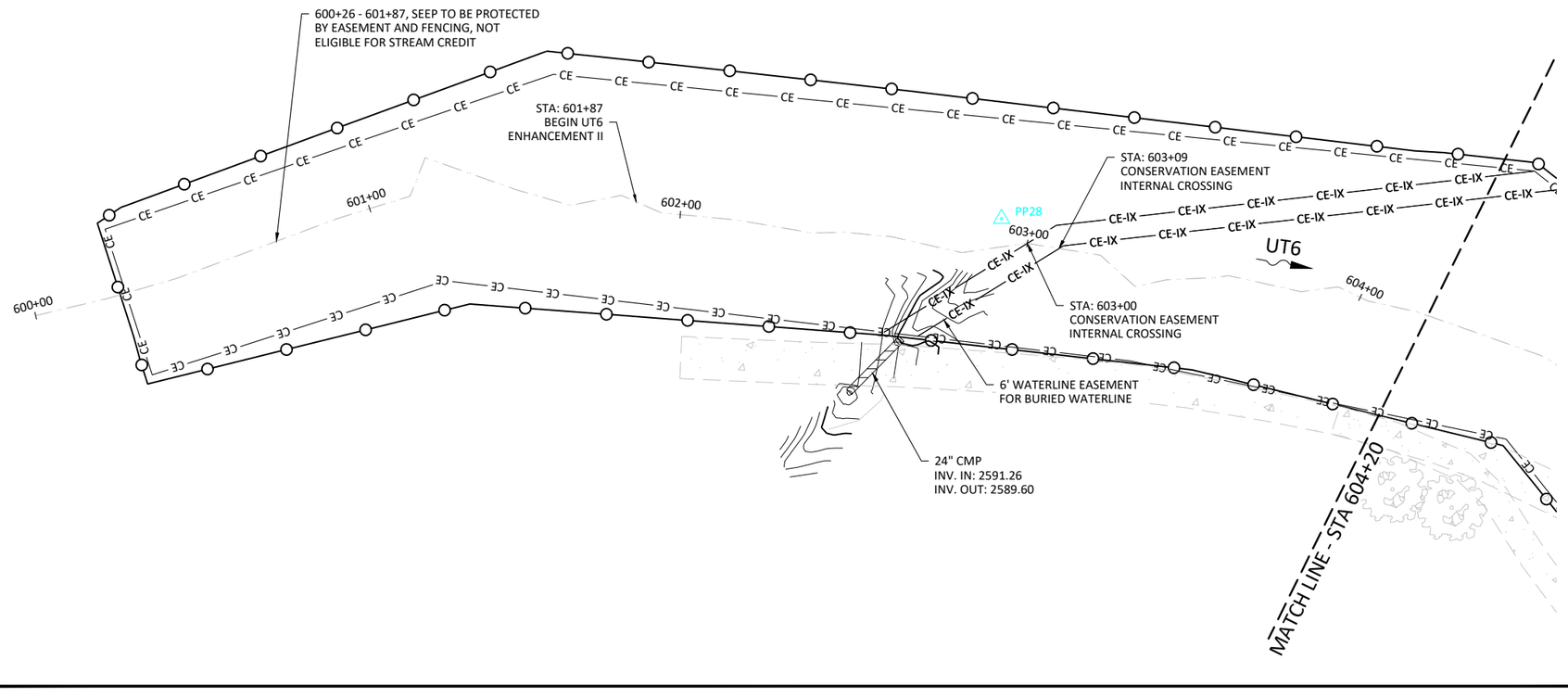

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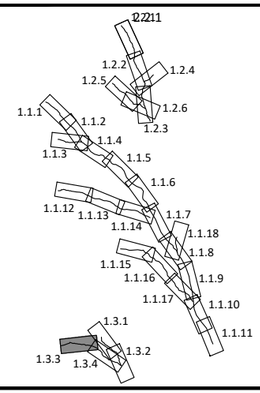

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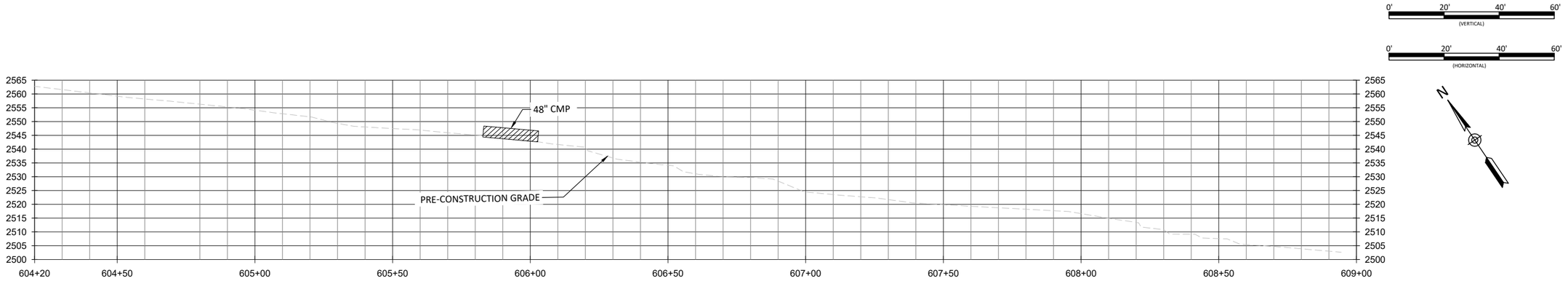
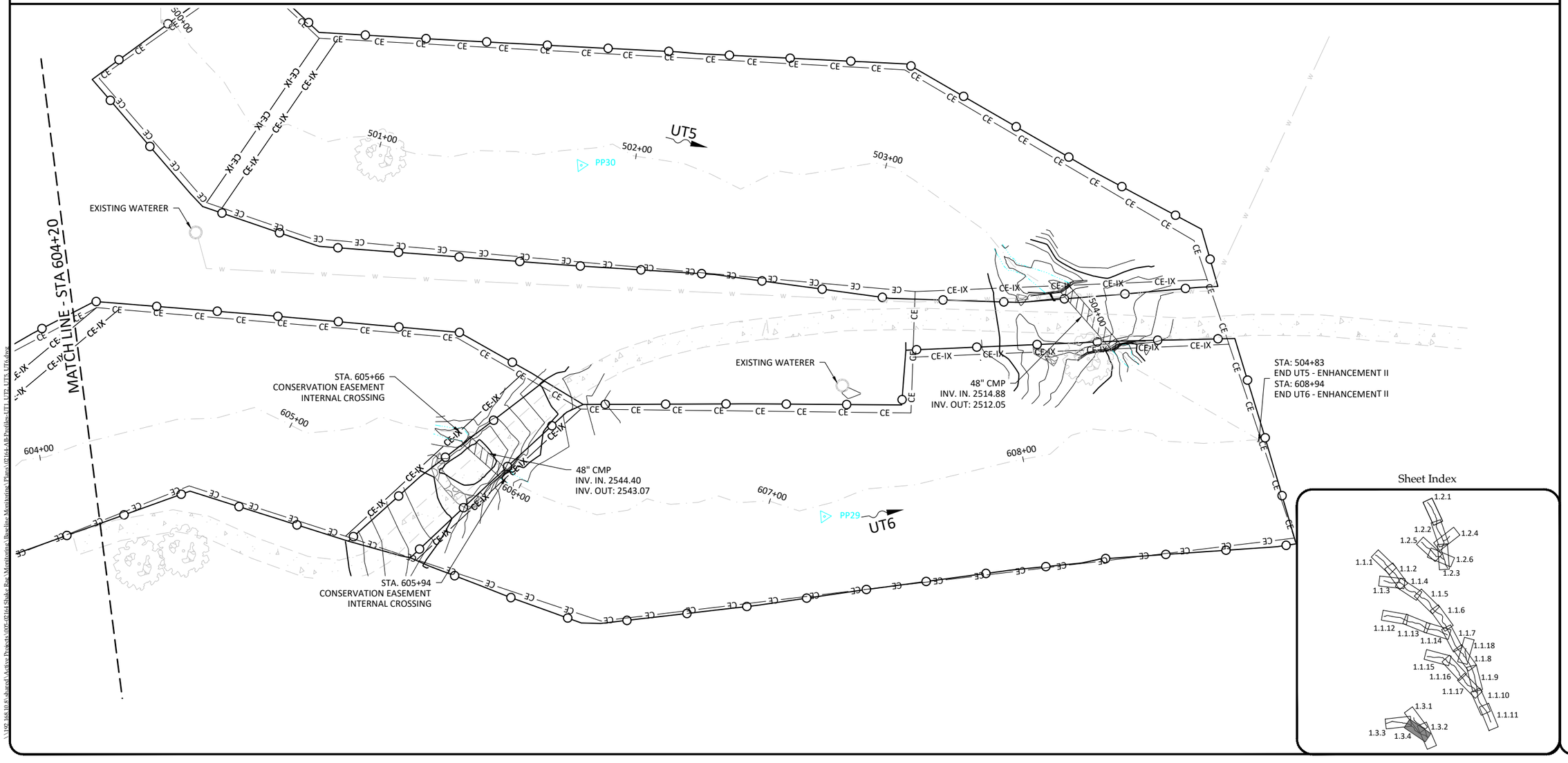
Checked By:	JK

Sheet 1.3.3





Sheet Index

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

UT6
Stream Plan and Profile

Revisions:

Date:	April 23, 2020
Job Number:	055-02164
Project Engineer:	JM
Drawn By:	JTH
Checked By:	JK

1.3.4
Sheet

Open Areas

Open Area Buffer Planting

Open Buffer Planting Zone Trees						
Bare Root						
Species	**Common Name**	**Max Spacing**	**Indiv. Spacing**	**Min. Caliper Size**	**Stratum**	**# of Stems**
Nyssa sylvatica	Black Gum	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	7% ~~5%~~
Platanus occidentalis	Sycamore	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	15%
Betula nigra	River Birch	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	16% ~~12%~~
Liriodendron tulipifera	Tulip Poplar	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	11% ~~10%~~
Fraxinus pennsylvanica	Green Ash	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	7% ~~4%~~
~~*Prunus serotina*~~	~~Black cherry~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25"-1.0"~~	~~Canopy~~	~~9%~~
Quercus rubra	Red Oak	12ft.	6-12 ft.	0.25"-1.0"	Canopy	11% ~~10%~~
~~*Betula lenta*~~	~~Sweet birch~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25"-1.0"~~	~~Canopy~~	~~8%~~
Quercus falcata	Southern Red Oak	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	11% ~~10%~~
Diospyros virginiana	Persimmon	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	5%
Fagus grandifolia	American Beech	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	7% ~~2%~~
Quercus alba	White Oak	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	7%
					Total	97% ~~90%~~
Alternates						
~~*Acer saccharinum*~~	~~Silver maple~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25”-1.0”~~	~~Canopy~~	~~0%~~
~~*Halesia caroliniana*~~	~~Carolina silverbell~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25”-1.0”~~	~~Canopy~~	~~0%~~
	~~White ash~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25"-1.0"~~	~~Canopy~~	~~0%~~
	~~American beech~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25"-1.0"~~	~~Canopy~~	~~0%~~
					Total	0%

Open Buffer Planting Zone Small Trees / Shrubs						
Bare Root						
Species	**Common Name**	**Max Spacing**	**Indiv. Spacing**	**Min. Caliper Size**	**Stratum**	**# of Stems**
~~*Alnus serrulata*~~	~~Tag Alder~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25"-1.0"~~	~~Canopy~~	~~2%~~
Hamamelis virginiana	Witch Hazel	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	2%
Cornus florida	Flowering Dogwood	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	2%
Lindera benzoin	Spicebush	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	2%
~~*Amelanchier arborea*~~	~~Serviceberry~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25"-1.0"~~	~~Canopy~~	~~2%~~
Ilex decidua	Possumhaw	12 ft.	6-12 ft.	0.25"-1.0"	Shrub	1%
Rosa palustris	Swamp rose	12 ft.	6-12 ft.	0.25"-1.0"	Shrub	1%
Oxydendrum arboreum	Sourwood	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	1%
					Total	3% ~~10%~~

Partially Vegetated Areas

Partially Vegetated Area Buffer Planting

Partially Vegetaded Buffer Planting Zone Trees						
Bare Root						
Species	**Common Name**	**Max Spacing**	**Indiv. Spacing**	**Min. Caliper Size**	**Stratum**	**# of Stems**
Nyssa sylvatica	Black Gum	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	6% ~~5%~~
Platanus occidentalis	Sycamore	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	13% ~~10%~~
Betula nigra	River Birch	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	12% ~~10%~~
Liriodendron tulipifera	Tulip Poplar	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	10% ~~5%~~
Fraxinus pennsylvanica	Green Ash	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	6% ~~5%~~
~~*Prunus serotina*~~	~~Black cherry~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25"-1.0"~~	~~Canopy~~	~~10%~~
Quercus rubra	Northern Red Oak	12ft.	6-12 ft.	0.25"-1.0"	Canopy	8% ~~10%~~
Quercus alba	White Oak	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	4%
~~*Betula lenta*~~	~~Sweet birch~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25"-1.0"~~	~~Canopy~~	~~5%~~
~~*Quercus falcata var. pagodifolia*~~	~~Cherrybark Oak~~ Southern Red Oak	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	10% ~~10%~~
Diospyros virginiana	Persimmon	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	5%
Fagus grandifolia	American Beech	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	4%
					Total	76% ~~75%~~
Alternates						
~~*Acer saccharinum*~~	~~Silver maple~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25”-1.0”~~	~~Canopy~~	~~0%~~
~~*Halesia caroliniana*~~	~~Carolina silverbell~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25”-1.0”~~	~~Canopy~~	~~0%~~
Alnus serrulata	Tag alder	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	0%
					Total	~~0%~~

Partially Vegetated Buffer Planting Zone Small Trees / Shrubs						
Bare Root						
Species	**Common Name**	**Max Spacing**	**Indiv. Spacing**	**Min. Caliper Size**	**Stratum**	**# of Stems**
Hamamelis virginiana	Witch Hazel	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	3% ~~5%~~
~~*Cornus florida*~~	~~Flowering Dogwood~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25”-1.0”~~	~~Canopy~~	~~4%~~
Lindera benzoin	Spicebush	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	3% ~~5%~~
~~*Aesculus sylvatica*~~	~~Painted Buckeye~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25”-1.0”~~	~~Canopy~~	~~4%~~
Amelanchier arborea	Serviceberry	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	3% ~~7%~~
Vaccinium corymbosum	Blueberry	12 ft.	6-12 ft.	0.25"-1.0"	Shrub	3%
Oxydendrum arboreum	Sourwood	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	3%
Calycanthus floridus	Eastern sweetshrub	12 ft.	6-12 ft.	0.25"-1.0"	Shrub	3%
Ilex opaca	American holly	12 ft.	6-12 ft.	0.25"-1.0"	Shrub	3%
					Total	21% ~~25%~~
Alternates						
~~*Carpinus caroliniana*~~	~~Ironwood~~	~~12 ft.~~	~~6-12 ft.~~	~~0.25”-1.0”~~	~~Canopy~~	~~0%~~
Ostrya virginiana	Eastern hophornbeam	12 ft.	6-12 ft.	0.25”-1.0”	Canopy	3% ~~0%~~
					Total	3% ~~0%~~

Riparian Corridor Planting

Riparian Corridor Planting (Streambanks)

Streambank Planting Zone						
Live Stakes						
Species	**Common Name**	**Max Spacing**	**Indiv. Spacing**	**Min. Size**	**Stratum**	**% of Stems**
Salix nigra	Black Willow	8 ft.	6-8 ft.	0.5”-1.5” cal.	Shrub	12% ~~10%~~
Cornus amomum	Silky Dogwood	8 ft.	6-8 ft.	0.5”-1.5” cal.	Shrub	27% ~~20%~~
Salix sericea	Silky Willow	8 ft.	6-8 ft.	0.5”-1.5” cal.	Shrub	32% ~~20%~~
Physocarpos opulifolius	Ninebark	8 ft.	6-8 ft.	0.5”-1.5” cal.	Shrub	17% ~~20%~~
Cephalathus occidentalis	Buttonbush	8 ft.	6-8 ft.	0.5"-1.5" cal.	Shrub	12% ~~15%~~
~~*Sambucus canadensis*~~	~~Elderberry~~	~~8 ft.~~	~~6-8 ft.~~	~~0.5"-1.5" cal.~~	~~Shrub~~	~~15%~~
					Total	**100%**
Herbaceous Plugs						
Juncus effusus	Common Rush	5 ft.	3-5 ft.	1.0”- 2.0” plug	Herb	43% ~~40%~~
Carex alata	Broadwing Sedge	5 ft.	3-5 ft.	1.0”- 2.0” plug	Herb	43% ~~20%~~
Panicum virgatum	Switchgrass	5 ft.	3-5 ft.	1.0"-2.0" plug	Herb	10%
Hibiscus moscheutos	Marsh Hibiscus	5 ft.	3-5 ft.	1.0"-2.0" plug	Herb	1%
Iris virginica	Southern Blue Flag	5 ft.	3-5 ft.	1.0"-2.0" plug	Herb	1%
Lobelia cardinalis	Cardinal Flower	5 ft.	3-5 ft.	1.0"-2.0" plug	Herb	1%
Helianthus angustifolius	Swamp Sunflower	5 ft.	3-5 ft.	1.0"-2.0" plug	Herb	1%
~~*Carex lurida*~~	~~Lurid Sedge~~	~~5 ft.~~	~~3-5 ft.~~	~~1.0"- 2.0" plug~~	~~Herb~~	~~20%~~
~~Scirpus cyperinus~~	~~Woolgrass~~	~~5 ft~~	~~3-5 ft.~~	~~1.0"-2.0" plug~~	~~Herb~~	~~20%~~
					Total	**100%**

Permanent Seeding

Riparian Seeding - Open Canopy				
Pure Live Seed (20 lbs/ acre)				
Approved Date	**Species Name**	**Common Name**	**Stratum**	**Density (lbs/acre)**
All Year	*Panicum rigidulum*	Redtop Panicgrass	Herb	1.0
All Year	*Panicum virgatum*	Switchgrass	Herb	1.0
All Year	*Chasmanthium latifolium*	River Oats	Herb	1.0
All Year	*Rudbeckia hirta*	Blackeyed Susan	Herb	1.0
All Year	*Coreopsis lanceolata*	Lanceleaf Coreopsis	Herb	1.0
All Year	*Carex vulpinoidea*	Fox Sedge	Herb	2.0
All Year	*Panicum clandestinum*	Deertongue	Herb	4.0
All Year	*Elymus virginicus*	Virginia Wild Rye	Herb	4.0
All Year	*Sorghastrum nutans*	Indiangrass	Herb	3.0
All Year	*Bidens aristosa*	Bur-Marigold	Herb	1.0
All Year	*Helianthus angustifolius*	Swamp Sunflower	Herb	1.0

Pasture Seeding

Pasture Seeding		
Pure Live Seed (32 lbs/ac)		
Species Name	**Common Name**	**lbs/acre**
Festuca arundinacea	Fescue (KY 31)	20
Dactylis glomerata	Orchard grass	12

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina
Planting List

Revisions:

Date: April 23, 2020
Job Number: 055-02164
Project Engineer: JM
Drawn By: JTH
Checked By: JK

Sheet 2.1

NOTE:
NO PLANTING ZONES
CHANGED FOR THE AS-BUILT

0' 100' 200' 300'
(HORIZONTAL)

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

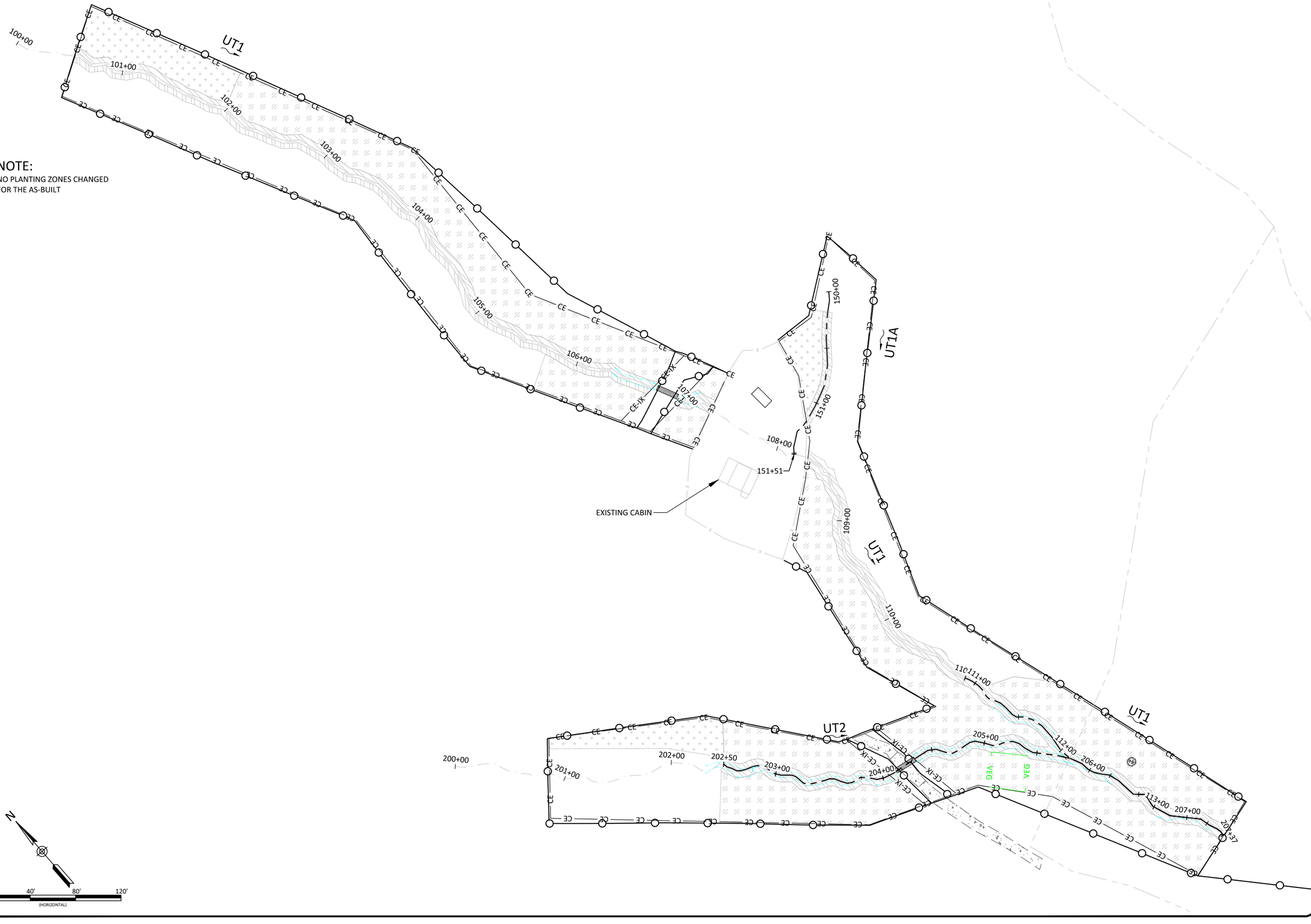
Shake Rag Branch, UT3, UT4, and UT8
Planting Plan

Revisions:

Date: April 23, 2020
Job Number: 055-02164
Project Engineer: JM
Drawn By: JTH
Checked By: JK

Sheet 2.2

NOTE:
NO PLANTING ZONES CHANGED
FOR THE AS-BUILT



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Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

UT1 and UT2
Planting Plan

Date:	April 23, 2020
Job Number:	055-02164
Project Engineer:	JM
Drawn By:	JTH
Checked By:	JK

Revisions:

Sheet 2.3

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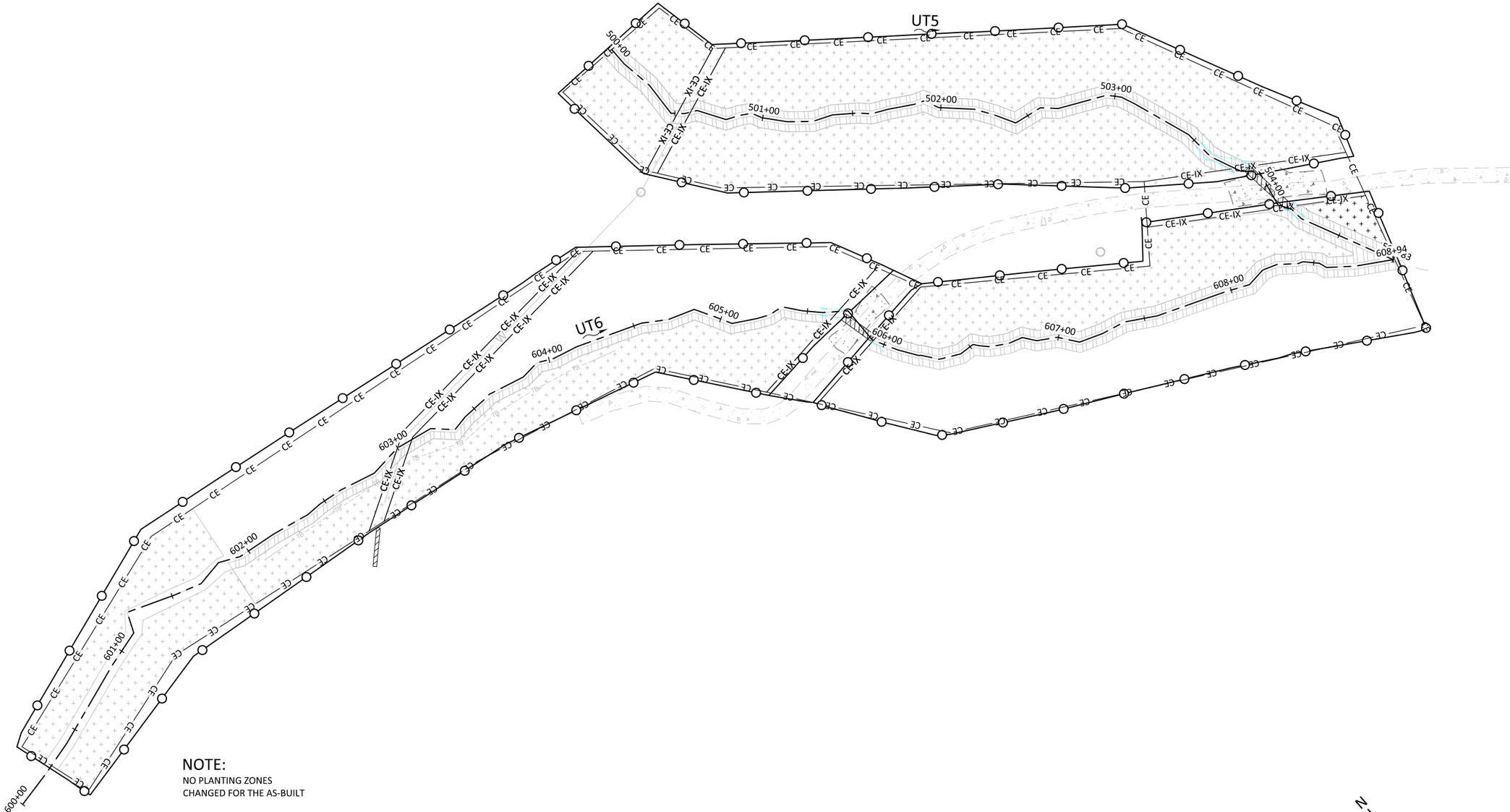

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NORTH CAROLINA PROFESSIONAL SEAL 033578 ENGINEER JACOB P. McLEAN

Shake Rag Branch Mitigation Site Record Drawings
Madison County, North Carolina

UT5 and UT6
Planting Plan

Revisions:

Date:	April 23, 2020
Job Number:	055-02164
Project Engineer:	JM
Drawn By:	JTH
Checked By:	JK

Sheet 2.4